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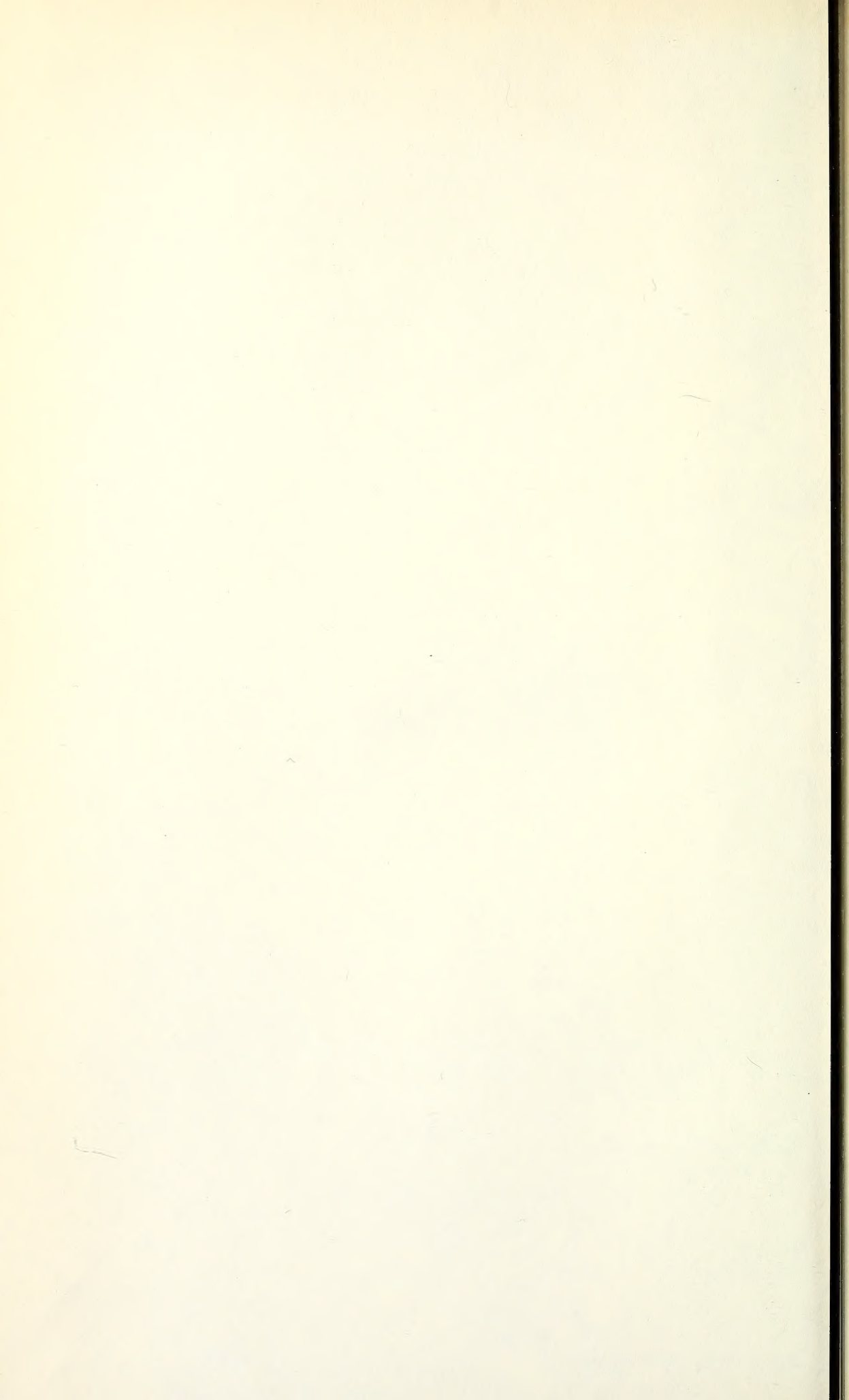
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THE PENNSYLVANIA STATE  
UNIVERSITY BULLETIN



GRADUATE SCHOOL  
ANNOUNCEMENT ~ 1958-1959

OFFICE OF THE GRADUATE SCHOOL  
104 Willard Building



The post office address of The Pennsylvania State University is University Park, Pennsylvania, but the town in which the University is located is State College.



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UNIVERSITY PARK, PENNSYLVANIA



THE PENNSYLVANIA STATE  
UNIVERSITY BULLETIN

*Graduate School*  
*Announcement*

1958-1959



UNIVERSITY PARK, PENNSYLVANIA

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# GRADUATE CALENDAR

## *SPRING SEMESTER 1958*

### JANUARY 1958

- Jan. 29- } Wednesday to Saturday—Spring Semester Registration  
Feb. 1 } Wednesday to Saturday—Oral Examination in Foreign Languages for  
          } Doctoral Candidates

### FEBRUARY

- 3 Monday—Spring Semester Classes Begin 8 a.m.  
3 Monday—Last Date for Registering with Foreign Language Departments  
for Written Language Examinations  
15 Saturday—Last Date for Students to Add Courses  
20 Thursday—Graduate Faculty Meeting 4:10 p.m.

### MARCH

- 1 Saturday—Last Date for Students to Drop Courses  
3 Monday—Written Foreign Language Examination for Doctoral Candidates 7 p.m.  
15 Saturday—Last Date for Signing of Diploma Card and Payment of Thesis Binding Fee for June Graduates  
20 Thursday—Graduate Faculty Meeting 4:10 p.m.

### APRIL

- 2 Wednesday—Spring Recess Begins 11:50 a.m.  
9 Wednesday—Spring Recess Ends 1:10 p.m.  
17 Thursday—Graduate Faculty Meeting 4:10 p.m.

### MAY

- 10 Saturday—Last Date for a June Graduate to Deliver Doctoral Thesis to Committee  
15 Thursday—Graduate Faculty Meeting 4:10 p.m.  
17 Saturday—Last Date for a June Graduate to Deliver Master's Thesis to Adviser  
17 Saturday—Last Date for Final Oral Doctoral Examination for June Graduates  
17 Saturday—Cap and Gown Fee Due 5:30 p.m.  
24 Saturday—Spring Semester Classes End 11:50 a.m.  
24 Saturday—Theses Due in Graduate School Office 12 noon  
24 Saturday—Spring Semester Examinations Begin 1:10 p.m.  
30 Friday—Memorial Day Recess

### JUNE

- 4 Wednesday—Spring Semester Ends 12:30 p.m.  
7 Saturday—Commencement Day



## SUMMER SESSIONS 1958

### JUNE 1958

- 9 Monday—Registration for Inter-Session in a.m.
- 9 Monday—Inter-Session Classes Begin 2 p.m.
- 27 Friday—Inter-Session Ends 4:50 p.m.
- 30 Monday—Registration for Main Summer Session

### JULY

- 1 Tuesday—Oral Examinations in Foreign Languages for Doctoral Candidates and Registration for Written Examinations
- 1 Tuesday—Main Summer Session Classes Begin 8 a.m.
- 4 Friday—Independence Day Recess
- 11 Friday—Last Date for an August Graduate to Deliver Doctoral Thesis to Committee
- 11 Friday—Last Date for Signing of Diploma Card and Payment of Thesis Binding Fee for August Graduates
- 18 Friday—Last Date for an August Graduate to Deliver Master's Thesis to Adviser
- 18 Friday—Last Date for Final Oral Doctoral Examination for August Graduates
- 19 Saturday—Cap and Gown Fee Due 5:30 p.m.
- 25 Friday—Theses Due in Graduate Office 5 p.m.
- 28 Monday—Written Foreign Language Examinations for Doctoral Candidates 7 p.m.

### AUGUST

- 8 Friday—Main Summer Session Ends 4:50 p.m.
- 9 Saturday—Main Summer Session Graduation Exercises
- 11 Monday—Registration for Post-Session in a.m.
- 11 Monday—Post-Session Classes Begin 2 p.m.
- 29 Friday—Post-Session Ends 4:50 p.m.

## FALL SEMESTER 1958

### SEPTEMBER 1958

- 10-13 Wednesday to Saturday—Fall Semester Registration
- 10-13 Wednesday to Saturday—Oral Examinations in Foreign Languages for Doctoral Candidates
- 15 Monday—Fall Semester Classes Begin 8 a.m.
- 26 Friday—Convocation of the Graduate School 7:30 p.m.
- 27 Saturday—Last Date for Students to Add Courses

### OCTOBER

- 6 Monday—Last Date for Registering with Foreign Language Departments for Written Language Examinations
- 11 Saturday—Last Date for Students to Drop Courses
- 16 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 25 Saturday—Last Date for Signing of Diploma Card and Payment of Thesis Binding Fee for January Graduates

## NOVEMBER

- 3 Monday—Written Foreign Language Examinations for Doctoral Candidates 7 p.m.
- 20 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 26 Wednesday—Thanksgiving Recess Begins 11:50 a.m.

## DECEMBER

- 1 Monday—Thanksgiving Recess Ends 8 a.m.
- 18 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 20 Saturday—Christmas Recess Begins 11:50 a.m.
- 27 Saturday—Last Date for a January Graduate to Deliver Doctoral Thesis to Committee

## JANUARY 1959

- 3 Saturday—Last Date for a January Graduate to Deliver Master's Thesis to Adviser
- 3 Saturday—Last Date for Final Oral Doctoral Examination for January Graduates
- 5 Monday—Christmas Recess Ends 8 a.m.
- 10 Saturday—Theses Due in Graduate School Office 12 noon
- \*14 Wednesday—Fall Semester Classes End 5 p.m.
- 15 Thursday—Fall Semester Examinations Begin 8 a.m.
- 23 Friday—Fall Semester Ends 5:30 p.m.
- 25 Sunday—Fall Semester Graduation Exercises

## *SPRING SEMESTER 1959*

## JANUARY 1959

- 28-31 Wednesday to Saturday—Spring Semester Registration
- 28-31 Wednesday to Saturday—Oral Examinations in Foreign Languages for Doctoral Candidates

## FEBRUARY

- 2 Monday—Spring Semester Classes Begin 8 a.m.
- 2 Monday—Last Date for Registering with Foreign Language Departments for Written Language Examinations
- 14 Saturday—Last Date for Students to Add Courses
- 19 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 28 Saturday—Last Date for Students to Drop Courses

## MARCH

- 2 Monday—Written Foreign Language Examinations for Doctoral Candidates 7 p.m.
- 14 Saturday—Last Date for Signing of Diploma Card and Payment of Thesis Binding Fee for June Graduates

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\* On Monday, January 12, the classes shall be according to the Thursday schedule; on Tuesday, January 13, the classes shall be according to the Friday schedule; and on Wednesday, January 14, the morning classes will follow the Saturday schedule, and the afternoon classes will follow the normal Wednesday schedule.

- 19 Thursday—Graduate Faculty Meeting 4:10 p.m.  
25 Wednesday—Spring Recess Begins 11:50 a.m.

#### APRIL

- 1 Wednesday—Spring Recess Ends 1:10 p.m.  
16 Thursday—Graduate Faculty Meeting 4:10 p.m.

#### MAY

- 9 Saturday—Last Date for a June Graduate to Deliver Doctoral Thesis to Committee  
14 Thursday—Graduate Faculty Meeting 4:10 p.m.  
16 Saturday—Last Date for a June Graduate to Deliver Master's Thesis to Adviser  
16 Saturday—Last Date for Final Oral Doctoral Examination for June Graduates  
16 Saturday—Cap and Gown Fee Due 5:30 p.m.  
23 Saturday—Spring Semester Classes End 11:50 a.m.  
23 Saturday—Theses Due in Graduate School Office 12 noon  
23 Saturday—Spring Semester Examinations Begin 1:10 p.m.  
30 Saturday—Memorial Day Recess

#### JUNE

- 3 Wednesday—Spring Semester Ends 12:30 p.m.  
6 Saturday—Commencement Day



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 SHIOU-CHUAN SUN, Sc.D. (M.I.T.)  
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*Engineering Research*  
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## PROFESSORS

RAYMOND W. SWIFT, Ph.D. (Rochester)	<i>Animal Nutrition</i>
ROBERT W. TAFT, JR., Ph.D. (Ohio State)	<i>Chemistry</i>
SHELDON C. TANNER, M.A. (Utah)	<i>Business Law</i>
HAROLD I. TARPLEY, M.S. (Illinois), P.E.	<i>Electrical Engineering</i>
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GLENN N. THIEL, M.Ed. (Penn State)	<i>Physical Education</i>
GEORGE L. THUERING, M.S. (Penn State), M.E., P.E.	<i>Industrial Engineering</i>
HARRISON M. TIETZ, Ph.D. (Massachusetts)	<i>Anatomy and Physiology</i>
HOWARD O. TRIEBOLD, Ph.D. (Minnesota)	<i>Agricultural and Biological Chemistry</i>
O. FRANK TUTTLE, Ph.D. (M.I.T.)	<i>Geochemistry</i>
ABRAM W. VANDERMEER, Ph.D. (Chicago)	<i>Education</i>
EDWARD B. VAN ORMER, Ph.D. (Columbia)	<i>Psychology</i>
DOROTHY H. VEON, Ed.D. (Columbia)	<i>Education</i>
ROBERT K. VIERCK, M.S. (Iowa), P.E.	<i>Engineering Mechanics</i>
HERBERT A. WAHL, Ph.D. (Penn State)	<i>Botany</i>
PHILIP L. WALKER, JR., Ph.D. (Penn State)	<i>Fuel Technology</i>
JOHN B. WASHKO, Ph.D. (Wisconsin)	<i>Agronomy</i>
R. HADLY WATERS, Ph.D. (Pennsylvania)	<i>Transportation</i>
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WAYNE WEBB, Ph.D. (Iowa)	<i>Physics</i>
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WILLIAM L. WERNER, M.A. (Penn State)	<i>American Literature</i>
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DONALD E. HARDENBERGH, M.S. (Penn State)	Engineering Mechanics
JOHN R. HAYES, Ph.D. (Penn State)	Chemistry
CARROLL E. HEIST, Ph.D. (Illinois)	Bacteriology
EDWARD S. HERMAN, Ph.D. (California)	Economics
RODNEY E. HERSH, M.S. (Penn State)	Chemical Engineering
E. ELIZABETH HESTER, Ph.D. (Cornell)	Foods and Nutrition
ELIZABETH C. HILLIER, Ph.D. (Ohio State)	Home Economics Education
CLIFFORD B. HOLT, JR., M.S. (Penn State), P.E.	Electrical Engineering
ALBERT H. HOLTZINGER, Ph.D. (Penn State)	Chemistry
PAUL D. HOLTZMAN, Ph.D. (Southern California)	Speech
CHARLES L. HOSLER, JR., Ph.D. (Penn State)	Meteorology
L. AILEEN HOSTINSKY, Ph.D. (Illinois)	Mathematics
ALIDA S. HOTCHKISS, Ph.D. (Cornell)	Home Management and Family Economics
LING-WEN HU, Ph.D. (Penn State)	Engineering Mechanics
LYMAN C. HUNT, JR., D.Ed. (Syracuse)	Education
HARRY K. HUTTON, D.Ed. (Penn State)	Education
ROBERT F. HUTTON, Ph.D. (Harvard)	Farm Management
LOIS B. HYSLOP, Ph.D. (Wisconsin)	Romance Languages
HENRY W. JOHNSTONE, JR., Ph.D. (Harvard)	Philosophy
JENNINGS H. JONES, Ph.D. (Penn State)	Chemistry
JOSEPH JORDAN, Ph.D. (Hebrew University, Jerusalem)	Chemistry
THEODORE K. KARHAN, M.Ed. (Penn State)	Music and Music Education
JACOB J. KAUFMAN, Ph.D. (Columbia)	Economics
EARL M. KESLER, Ph.D. (Penn State)	Dairy Science
E. ERWIN KLAUS, Ph.D. (Penn State)	Petroleum Chemistry
LEON R. KNEEBONE, Ph.D. (Penn State)	Botany and Plant Pathology
BORIS J. KOCHANOWSKY, Dr.Ing. (Clausthal)	Mining Engineering
CHARLES F. LEEDECKER, Ph.D. (Penn State)	Political Science
ARTHUR O. LEWIS, JR., Ph.D. (Penn State)	English Literature
EUGENE S. LINDSTROM, Ph.D. (Wisconsin)	Bacteriology
A. PAULINE LOCKLIN, M.A. (Illinois)	English Literature
MILDRED A. LUCEY, Ph.D. (N.Y.U.)	Physical Education
M. FRANK MALLETT, Ph.D. (Columbia)	Agricultural and Biological Chemistry
E. ORTH MALOTT, Ph.D. (Northwestern)	Finance
VACLAV MARES, Ph.D. (Charles University, Prague)	Economics
CHARLES R. MARSH, M.S. (Illinois)	Electrical Engineering
WILLIAM H. MARTIN, Ph.D. (Harvard)	Economics
WILL E. MASON, Ph.D. (Princeton)	Economics

EDWARD L. MATTIL, D.Ed. (Penn State)  
 ROBERT H. MCCORMICK, M.S. (Penn State)  
 EVERETT R. McLAUGHLIN, M.S. (Penn State), P.E.  
 NEIL A. McNALL, Ph.D. (Cornell)  
 MALCOLM C. McQUARRIE, Sc.D. (M.I.T.)  
 WARREN W. MILLER, Ph.D. (California)  
 JEANETTE MOLLOY, M.A. (Columbia)  
 J. HERBERT MOORE, M.S. (Penn State), P.E.  
 ARNULF I. MUAN, Ph.D. (Penn State)  
 ROBERT K. MURRAY, Ph.D. (Ohio State)  
 EUGENE A. MYERS, Ph.D. (Pittsburgh)  
 VERNON W. MYERS, Ph.D. (Yale)  
 WILLIAM T. NEARN, D.For. (Yale)  
 HAROLD E. NELSON, Ph.D. (Iowa)  
 MONROE NEWMAN, Ph.D. (Illinois)  
 FRANCENA L. NOLAN, Ph.D. (Penn State)  
 PAUL F. NORTON, Ph.D. (Princeton)  
 EDWIN P. NYE, M.S. (Harvard), P.E.  
 GILMA M. OLSON, M.S. (Minnesota)  
 HOWARD B. PALMER, Ph.D. (Wisconsin)  
 LESLIE M. PAPE, Ph.D. (Chicago)  
 JEROME K. PASTO, Ph.D. (Cornell)  
 STUART PATTON, Ph.D. (Ohio State)  
 NORMAN C. PENDERED, D.Ed. (Penn State)  
 RUTH L. PIKE, Ph.D. (Chicago)  
 WILLIAM S. RAY, Ph.D. (Maryland)  
 ROBERT R. REED, Jr., Ph.D. (Columbia)  
 ROBERT D. REIFSNEIDER, M.A. (Michigan)  
 SARA A. RHUE, Ph.D. (Iowa)  
 NEAL RIEMER, Ph.D. (Harvard)  
 C. MARSHALL RITTER, Ph.D. (Ohio State)  
 H. DAVID RIX, Ph.D. (Princeton)  
 ALLAN L. RODGERS, Ph.D. (Wisconsin)  
 LÉON S. ROUDIEZ, Ph.D. (Columbia)  
 RICHARD O. ROWLANDS, M.Sc. (Wales)  
 CHARLES W. RUTSCHKY, Ph.D. (Cornell)  
 CHRISTINE F. SALMON, M.Arch. (Pennsylvania), R.A.  
 F. CUTHBERT SALMON, M.Arch. (Pennsylvania), R.A.  
 JOHN J. SCHANZ, JR., Ph.D. (Penn State)  
 JOHN M. SCHEMPF, Ph.D. (Cornell)  
 ROBERT SCHOLTEN, Ph.D. (Michigan)  
 MARY P. SHELTON, Ed.D. (Columbia)  
 PAUL E. SHIELDS, M.S. (Pittsburgh), E.E., P.E.  
 SIDNEY SIEGEL, Ph.D. (Stanford)  
 BRUCE M. SIEGENTHALER, Ph.D. (Michigan)  
 RUTH C. SILVA, Ph.D. (Michigan)  
 PHILIP S. SKELL, Ph.D. (Duke)  
 CYRIL B. SMITH, Ph.D. (Penn State)  
 JOSEPH V. SMITH, Ph.D. (Cambridge)  
 WARREN S. SMITH, M.A. (Iowa)  
 LEO H. SOMMER, Ph.D. (Penn State)  
 WILLIAM SPACKMAN, JR., Ph.D. (Harvard)  
 C. DREW STAHL, Ph.D. (Penn State)

*Art Education*  
*Chemical Engineering*  
*Engineering Research*  
*American History*  
*Ceramic Technology*  
*Chemistry*  
*Elementary Education (part-time)*  
*Civil Engineering*  
*Metallurgy*  
*American History*  
*Economics*  
*Physics*  
*Wood Utilization*  
*Speech*  
*Economics*  
*Rural Sociology*  
*History of Art and Architecture*  
*Mechanical Engineering*  
*Foods and Nutrition*  
*Fuel Technology*  
*Philosophy*  
*Farm Management*  
*Dairy Science*  
*Industrial Arts Education*  
*Foods and Nutrition*  
*Psychology*  
*English Composition*  
*Theatre Arts*  
*Elementary Education*  
*Political Science*  
*Pomology*  
*Physics*  
*Geography*  
*Romance Languages*  
*Electrical Engineering*  
*Entomology*  
*Housing and Home Art*  
*Architecture*  
*Mineral Economics*  
*Chemistry*  
*Petroleum Geology*  
*Clothing and Textiles Research*  
*Electrical Engineering*  
*Psychology*  
*Clinical Speech*  
*Political Science*  
*Chemistry*  
*Plant Nutrition*  
*Mineralogy*  
*Theatre Arts*  
*Chemistry*  
*Paleobotany*  
*Petroleum and Natural Gas Engineering*

## ASSOCIATE PROFESSORS

F. BRISCOE STEPHENS, Ph.D. (Penn State)	<i>Meteorology</i>
RICHARD G. STONER, Ph.D. (Princeton)	<i>Physics</i>
WERNER F. STRIEDIECK, Ph.D. (Michigan)	<i>German</i>
DENO G. THEVAOS, Ed.D. (Columbia)	<i>Psychology</i>
GERALD M. TORKELSON, D.Ed. (Penn State)	<i>Visual Education</i>
CLARENCE E. TROTTER, Ph.D. (Minnesota)	<i>Marketing</i>
LOREN D. TUKEY, Ph.D. (Ohio State)	<i>Pomology</i>
WALTER H. WALTERS, Ph.D. (Western Reserve)	<i>Theatre Arts</i>
HAROLD V. WALTON, M.S. (Penn State)	<i>Agricultural Engineering</i>
THOMAS WARTIK, Ph.D. (Chicago)	<i>Chemistry</i>
GEORGE H. WATROUS, Jr., Ph.D. (Penn State)	<i>Dairy Manufacturing</i>
ROBERT L. WEBER, Ph.D. (Penn State)	<i>Physics</i>
FRANCIS L. WHALEY, Ph.D. (Michigan)	<i>Psychology</i>
THOMAS A. WIGGINS, Ph.D. (Penn State)	<i>Physics</i>
EDWIN T. WILLIAMS, Ph.D. (Penn State)	<i>Chemical Engineering</i>
MERRILL WOOD, M.S. (Penn State)	<i>Zoology</i>
HAROLD D. WRIGHT, Ph.D. (Columbia)	<i>Mineralogy</i>
JAMES E. WRIGHT, Ph.D. (Cornell)	<i>Genetics</i>
HENRY L. YEAGLEY, Ph.D. (Penn State)	<i>Physics</i>
KELLY YEATON, M.A. (Washington)	<i>Theatre Arts</i>
LEONARD N. ZIMMERMAN, Ph.D. (Cornell)	<i>Bacteriology</i>
HARRY D. ZOOK, Ph.D. (Penn State)	<i>Chemistry</i>
GEORGE S. ZORETICH, M.A. (Penn State)	<i>Art</i>

## ASSISTANT PROFESSORS

GALIP M. ARKILIC, Ph.D. (Northwestern)	<i>Engineering Mechanics</i>
BARKEV Y. BAKAMJIAN, Ph.D. (Columbia)	<i>Physics</i>
ROBERT V. BAUER, Ph.D. (Illinois)	<i>English Literature</i>
RUDOLF W. BECKING, Ph.D. (U. of Washington)	<i>Forestry</i>
JOHN E. BENSON, Ph.D. (Princeton)	<i>Chemistry</i>
LUTHER T. BISSEY, M.S. (Penn State)	<i>Petroleum and Natural Gas Engineering</i>
DONALD W. BLEZNICK, Ph.D. (Columbia)	<i>Romance Languages</i>
JAMES R. BLOOM, Ph.D. (Wisconsin)	<i>Plant Pathology</i>
SIDNEY A. BOWHILL, Ph.D. (Cambridge)	<i>Electrical Engineering</i>
BARRY S. BRINSMAID, M.A. (Columbia)	<i>Music</i>
ROBERT S. BRUBAKER, Ph.D. (Illinois)	<i>Speech</i>
CLYDE R. BURNETT, Ph.D. (Wisconsin)	<i>Physics</i>
C. WAYNE BURNHAM, Ph.D. (California Tech.)	<i>Economic Geology</i>
H. BRUCE BYLUND, Ph.D. (Penn State)	<i>Rural Sociology</i>
ROBERT N. CLAYTON, Ph.D. (California Tech.)	<i>Geochemistry</i>
RICHARD W. CLEVELAND, Ph.D. (California)	<i>Agronomy</i>
H. TREVOR COLBOURN, Ph.D. (Johns Hopkins)	<i>History</i>
JAMES H. COPP, Ph.D. (Wisconsin)	<i>Rural Sociology</i>
HOUSTON B. COUCH, Ph.D. (California)	<i>Plant Pathology</i>
LLOYD A. CURRIE, Ph.D. (Chicago)	<i>Chemistry</i>
HOLLE G. DEBOER, M.A. (Colorado State College of Education)	<i>Public Speaking</i>
JOHN P. DRISCOLL, Ph.D. (Penn State)	<i>Education</i>
JOHN A. FITZ, D.Ed. (Denver)	<i>Education</i>
FREDERICK C. FLIEGEL, Ph.D. (Wisconsin)	<i>Rural Sociology</i>
GEORGE J. FRITZ, Ph.D. (Purdue)	<i>Botany</i>
NICHOLAS FUSCHILLO, Ph.D. (Leeds)	<i>Physics</i>



# ASSISTANT PROFESSORS

PAUL C. GILMORE, Dr.Math. (Amsterdam)	<i>Mathematics</i>
RICHARD E. GLICK, Ph.D. (California)	<i>Chemistry</i>
LIONEL GOODMAN, Ph.D. (Iowa State)	<i>Chemistry</i>
ROBERT W. GREEN, Ph.D. (Iowa)	<i>History</i>
PAUL GRUN, Ph.D. (Cornell)	<i>Genetics</i>
LEONARD F. HERZOG, Ph.D. (M.I.T.)	<i>Geophysics</i>
ROLAND L. HICKS, D.Ed. (Penn State)	<i>Journalism</i>
HENRY HIZ, Ph.D. (Harvard)	<i>Mathematics</i>
GEORGE R. HUDSON, Ed.D. (Columbia)	<i>Education</i>
DOUGLAS N. JACKSON, JR., Ph.D. (Purdue)	<i>Psychology</i>
BERNARD R. JERMAN, Ph.D. (Ohio State)	<i>English Literature</i>
RICHARD N. JORGENSEN, D.For. (Yale)	<i>Wood Technology</i>
ROBERT E. KASKE, Ph.D. (North Carolina)	<i>English</i>
WALTER KATKOVSKY, Ph.D. (Ohio State)	<i>Psychology</i>
PHILIP G. KEENEY, Ph.D. (Penn State)	<i>Dairy Science</i>
ANTON J. KOVAR, Ph.D. (Rome)	<i>Botany</i>
DONALD T. LAIRD, Ph.D. (Penn State)	<i>Electrical Engineering</i>
LAURENCE H. LATTMAN, Ph.D. (Cincinnati)	<i>Geomorphology</i>
JOSEPH T. LAW, M.A. (Wisconsin)	<i>Political Science</i>
JOHN R. LOTZ, Ph.D. (Penn State)	<i>Chemistry</i>
HAROLD L. LOVELL, Ph.D. (Penn State)	<i>Mineral Sciences</i>
LAWRENCE F. MARRIOTT, Ph.D. (Wisconsin)	<i>Soil Technology</i>
ROBERT H. McALEXANDER, Ph.D. (Iowa State)	<i>Farm Management</i>
T. KING McCUBBIN, JR., Ph.D. (Johns Hopkins)	<i>Physics</i>
EDMUND V. MECH, Ph.D. (Indiana)	<i>Psychology</i>
DONALD F. MITCHELL, Ph.D. (U.C.L.A.)	<i>Genetics</i>
E. JAMES MOORE, Ph.D. (Michigan)	<i>Geophysics</i>
J. MITCHELL MORSE, Ph.D. (Penn State)	<i>English Composition</i>
GERALD M. MOSER, D.U.P. (Paris)	<i>Romance Languages</i>
WERNER J. MUELLER, Dr.Sc.Tech. (Swiss Fed. Inst. of Tech.)	<i>Poultry Husbandry</i>
GEORGE R. MURRAY, Ph.D. (M.I.T.)	<i>Chemistry</i>
JOHN B. NESBITT, Sc.D. (M.I.T.)	<i>Civil Engineering</i>
RICHARD P. NICKELSEN, Ph.D. (Johns Hopkins)	<i>Geology</i>
ROBERT S. NOVOSAD, Ph.D. (Chicago)	<i>Mathematics</i>
EUGENE K. OXHANDLER, D.Ed. (Columbia)	<i>Audio-Visual Education</i>
WILLIAM J. PAGE, Ed.D. (Temple)	<i>Education</i>
ELLEN V. PIERS, Ph.D. (George Peabody)	<i>Psychology</i>
JOHN E. PIXTON, JR., Ph.D. (Chicago)	<i>History</i>
THEODORE S. POLANSKY, Ph.D. (Penn State)	<i>Fuel Technology</i>
BERNARD L. POLLACK, Ph.D. (Penn State)	<i>Plant Breeding</i>
WILLIAM W. PRATT, Ph.D. (Iowa State)	<i>Physics</i>
MARGARET C. RAABE, M.S. (Penn State)	<i>Clinical Speech and Speech Education</i>
GUY E. RINDONE, Ph.D. (Penn State)	<i>Ceramic Technology</i>
WILLIAM J. ROSS, Ph.D. (New Zealand)	<i>Electrical Engineering</i>
DONALD P. SATCHELL, Ph.D. (North Carolina State)	<i>Soil Technology</i>
MARTIN W. SCHEIN, Sc.D. (Johns Hopkins)	<i>Animal Behavior</i>
RICHARD D. SCHEIN, Ph.D. (California)	<i>Plant Pathology</i>
ERWIN R. SCHMERLING, M.A. (Cambridge)	<i>Electrical Engineering</i>
LEE B. SECHREST, Ph.D. (Ohio State)	<i>Psychology</i>
MAURICE SHAMMA, Ph.D. (Wisconsin)	<i>Chemistry</i>
JAMES W. SHIGLEY, Ph.D. (Penn State)	<i>Agricultural and Biological Chemistry</i>
ALBERTA E. SIEGEL, Ph.D. (Stanford)	<i>Child Development and Family Relationships</i>
ALEX J. SLIVINSKE, Ph.D. (Virginia)	<i>Psychology</i>

## ASSISTANT PROFESSORS

THOMAS SMYTH, JR., Ph.D. (Johns Hopkins)	Entomology
FRANCIS J. SORAUF, Ph.D. (Wisconsin)	Political Science
WILLIAM A. STEELE, Ph.D. (Washington)	Chemistry
SIDNEY STEIN, Ph.D. (Stanford)	Electrical Engineering
ROBERT E. STOVER, Ph.D. (Penn State)	Psychology
H. TRACY STURCKEN, Ph.D. (North Carolina)	Romance Languages
JAMES TAMMEN, Ph.D. (California)	Plant Pathology
ALAN W. TAYLOR, Ph.D. (London)	Ceramic Technology
EDWARD C. THADEN, D.U.P. (Paris)	History
GEORGE A. THEODORSON, Ph.D. (Cornell)	Sociology
FRANK B. THOMAS, Ph.D. (Penn State)	Horticulture
CHARLES P. THORNTON, Ph.D. (Yale)	Petrography
J. BRUCE WAGNER, JR., Ph.D. (Virginia)	Metallurgy
DARRELL E. WALKER, Ph.D. (California)	Plant Breeding
FREDERICK L. WERNSTEDT, Ph.D. (U.C.L.A.)	Geography
SAMUEL F. WILL, JR., Ph.D. (Yale)	Classical Languages
ROLF G. WINTER, D.Sc. (Carnegie Tech.)	Physics
ARTHUR E. WOODWARD, Ph.D. (Brooklyn Polytech.)	Chemistry
RICHARD N. WORK, Ph.D. (Cornell)	Physics
GEORGE J. YOUNG, Ph.D. (Lehigh)	Fuel Technology
C. COURSON ZELIFF, Ph.D. (Cornell)	Zoology

## OTHER MEMBERS OF THE GRADUATE FACULTY

EDWARD ABRAMSON, A.M. (Pennsylvania)	Sociology
JOSEPH ALESSANDRO, D.Ed. (Penn State)	Education
CHRISTINE W. AYOUB, Ph.D. (Yale)	Mathematics
LESLIE P. GREENHILL, B.Com. (Melbourne)	Academic Research and Services
WARREN W. HASSLER, JR., Ph.D. (Johns Hopkins)	History
HELEN D. HILL, Ph.D. (Penn State)	Geneticist, U. S. Regional Pasture Research Laboratory
NORMAN K. HOOVER, D.Ed. (Penn State)	Agricultural Education
ROBERT W. HOUSE, M.S. (Ohio U.)	Electrical Engineering
KENNETH W. HYLBERT, D.Ed. (Penn State)	Rehabilitation Counseling
GERHARD O. W. KREMP, Dr.rer.nat. (Posen)	Geology
AMOS E. NEYHART, M.S. (Penn State)	Institute of Public Safety
ROBERT M. POCKRASS, M.S. (Illinois)	Journalism
CLARK C. SPENCE, Ph.D. (Minnesota)	History
DONALD B. SWEGAN, D.Ed. (Penn State)	Physical Education
WALTER F. WESTERFELD, M.S. (Penn State)	Botany
MARTIN L. ZEIGLER, Ph.D. (Penn State)	Division of Counseling

# GENERAL INFORMATION

**G**RADUATE WORK at The Pennsylvania State University was first offered in 1862 when two graduate students were in residence. It was given more formal recognition in 1864 by the establishment of a "course for Graduates" designed for students who, after receiving the degree of Bachelor of Scientific Agriculture, wished to do advanced work leading to the degree of Master of Scientific Agriculture. For some time there were few graduate students, and graduate instruction was relatively unorganized. Later a committee of the University Senate was given the responsibility of establishing standards and regulations governing graduate work and the granting of advanced degrees. The Graduate School was organized in 1922. Until this time only masters' degrees and certain technical degrees had been conferred. In 1924, upon recommendation of the Graduate School, the Board of Trustees authorized the granting of the degree of Doctor of Philosophy. Still later other degrees were approved.

The faculty of the Graduate School consists of the President and certain other general administrative officers of the University, the Deans, the University Examiner, the Librarian, the heads of departments, and those members of the instructional staff who have been authorized by the proper agencies of the Graduate School to offer graduate courses and supervise research leading to theses. It controls all academic matters pertaining to the Graduate School, subject to review by the University Senate.

The graduate faculty numbers approximately 625 members. Graduate student enrollment was about 1900 per semester in 1956-57 and about 2400 during the summer of 1957. The number of advanced degrees conferred in 1956-57 was 620, of which 130 were doctors' degrees.

## PROCEDURES AND REGULATIONS

A student is expected to assume full responsibility for knowing the regulations and pertinent procedures of the Graduate School (as set forth in the *Graduate School Announcement*, the *Manual for Graduate Students*, and the *Thesis Information Bulletin*) and for meeting the standards and requirements expressed by these regulations. The *Manual*, which is available to a student after he has been admitted, sets forth in more detail the general regulations outlined in the *Announcement* and furnishes other information about the Graduate School which is useful to graduate students. Every student should secure a copy of this manual from the Dean's Office as soon after admission as possible.

**ADMISSION**—An applicant for admission to the Graduate School should understand that graduate work is not an extension of undergraduate work. It operates at a definitely higher level, demands scholarship of a high order, and emphasizes research and creativity. It involves a minimum of formal requirements and regulations, and a maximum of student initiative and responsibility.

A student does not become a graduate student merely by enrolling for advanced courses after having received a baccalaureate degree. Formal admission to the Graduate School is required. Credits earned before admission cannot be applied to meet degree requirements at a later date even though admission may have been granted in the meantime.



## ADMISSION

Admission is granted by the Dean of the Graduate School after approval of the application for admission by the department in which the student plans to do his major work. Blanks to be used in making formal application for admission can be obtained from the Dean of Admissions. With his application each student should present the names of two persons to whom departments may write, and who are well qualified to evaluate his abilities for graduate work in the field of his choice. In general, students may begin their graduate work in the fall, spring, or summer.

An applicant for admission should provide complete credentials, in duplicate, sent directly from other institutions to the Dean of the Graduate School at least six weeks prior to the opening of the session in which he plans to begin his graduate program. If the applicant has attended more than one institution, two official transcripts of the work covered at each institution are required. This applies to the complete academic record, both undergraduate and graduate.

An applicant who has done considerable high quality graduate work in a graduate school known to maintain high standards will be considered on the basis of his entire record. Prospective students may write directly to the head of any department concerning graduate work in that specific field.

Foreign students are encouraged to write to the Director of International Student Affairs for information concerning financial matters, housing, and other nonacademic problems.

For unqualified admission to the Graduate School an applicant must have received a baccalaureate degree from an accredited institution, earned under residence and credit conditions substantially equivalent to those required by The Pennsylvania State University. He must have maintained during his junior and senior years a minimum grade point average equivalent to 2.5 on The Pennsylvania State University grading scale (equivalent to half B and half C for courses carrying the same number of credits). Finally, he must ordinarily have completed in a satisfactory manner a certain minimum of course work in designated areas, the specific courses and amount of required work depending upon the field of advanced study which the student proposes to enter. The minimum grade point average of 2.5 during the last two undergraduate years is a general requirement of the Graduate School. Individual departments may require a higher average for admission to advanced study in their fields.

Conditional admission may be granted to an applicant whose undergraduate grade point average is below 2.5 but whose qualifications in other respects seem to suggest probable success in the Graduate School, provided the applicant's admission is recommended by a major department. Such an applicant must realize that the initiative rests entirely with him in communicating with the department of his chosen major and that, if admitted conditionally, he does graduate work at his own risk. There is no assurance that he will subsequently be granted unqualified admission or that the credits earned will automatically be applied toward degree requirements.

Provisional admission may be granted to an applicant whose complete credentials are not available at the time of registration, but this admission will be subject to cancellation if the credentials, on their arrival, do not meet all the requirements for admission to the Graduate School. Also, certification of any scheduled credits while the applicant is holding provisional admission will be withheld until receipt of his official credentials makes possible his permanent admission to the Graduate School. If the provisional admission should, for any reason, be canceled, the student is thereby automatically dropped from the Graduate School and as a consequence will be required to cease attending any 500 level courses for which he may

have registered. He may continue to attend 400 level courses provided he applies for and is accepted for registration as a special student.

Formal readmission is not required year by year nor after one or more semesters of absence from the campus unless the student has completed more than 12 credits of work at another institution in the meantime. In this case readmission is required, and evidence of good standing at the institution involved is essential. A student who has earned a master's degree at The Pennsylvania State University should not register for further degree work until his academic record and personal qualifications have been reviewed critically by the department of his major interest and a candidacy evaluation has been completed.

The President of the University, on recommendation of the Dean of the Graduate School, will welcome doctors of philosophy of The Pennsylvania State University, as well as those of other accredited colleges and universities, as guests of the University, with the privilege of attending seminars and courses and of carrying on research in laboratories and libraries. There will be no charge except for laboratory expenses. Arrangements should be made in advance with the Dean of the Graduate School.

A senior student of The Pennsylvania State University lacking not more than 4 credits for graduation may be admitted to the Graduate School. This limit of 4 credits may be increased to 8 in the case of a student with an average of at least B (a grade point average of 3). Other senior students, while not admitted to the Graduate School, may, if their records are superior, schedule graduate courses (500 series) upon the approval of the instructor of the course to which the student desires admission, and of the Dean of the Graduate School.

**CLASSIFICATION**—At the time of admission to the University, students are classified as graduate, special, or undergraduate students, depending upon their objectives and qualifications.

A special student is not a graduate student, inasmuch as he has not been admitted to the Graduate School, and may not register for graduate courses or research (500 and 600 series) without permission of the Dean of the Graduate School. A special student may register for 400 level courses, provided he has attained at least junior standing in college. Except for most unusual reasons, a special student who is later admitted to the Graduate School may not then count toward degree requirements any credit he has earned while in the special student status.

Upon admission all graduate students are classified either as regular graduate students or as general graduate students. The essential difference between the two groups is that a regular graduate student is working toward an advanced degree at The Pennsylvania State University while a general graduate student is not. Regardless of classification, all students, upon admission to the Graduate School, must register through the Graduate Dean's office for all work taken, whether or not that work is to be credited toward the requirements for a degree.

Changes in classification are arranged through the Graduate School office and, in the case of a change from general to regular status, the approval of the head of the major department in which the student proposes to work is required.

Regular graduate students include those persons who plan to become candidates for degrees at The Pennsylvania State University and who have been formally admitted for advanced study in a particular field. The program of study is developed under the guidance of a department head or his representative. A graduate student who plans to be a candidate for an advanced degree should enroll as a regular graduate student.



## REGISTRATION

It should be emphasized that a student is not a "regular graduate student" unless he has been officially admitted to that status. Regular attendance in the Graduate School, or personal plans for future degree candidacy, do not in themselves carry with them the status or privileges of a regular graduate student.

A regular graduate student who has passed a candidacy evaluation is classified as a doctoral candidate.

An applicant who meets all requirements for admission to the Graduate School, but who does not wish to work for an advanced degree at this institution, may arrange for a program of work as a general graduate student. This classification includes those who plan to transfer credits to another institution and those who plan a special program of study not leading to an advanced degree.

The adviser for a general graduate student is appointed by the Dean of the Graduate School. The student's status and standing will be reviewed by the Dean at each registration. He may not remain a general graduate student longer than one semester (or summer sessions totaling 12 weeks) except with the permission of the Dean, and for definite and good reasons.

When a general graduate student wishes to become a regular graduate student—i.e., to work for an advanced degree at this institution—he should make application to the Dean of the Graduate School for change of status. His undergraduate record will then be re-evaluated to determine whether or not he is prepared to undertake graduate work for a degree in the major field of his choice. He should understand that he may thereafter apply toward degree requirements only those credits earned as a general graduate student which fit definitely and logically into an integrated degree program. There is no upper limit to the number of credits that may be so applied; neither is there any guarantee that any such credits may be applicable.

**REGISTRATION**—A student is required to register for each semester and each summer session in which he proposes to do course work or research, either on or off campus, except that a candidate who has met the minimum credit requirements for his degree is required to register further only for course work, project work, and for research work which requires the use of University facilities and supplies (laboratory, library, etc.). In the case of research, the number of credits shall be determined by the amount of time required for the investigation, one credit representing one week of full-time graduate work. This means, for instance, that if a student has completed three years of work (90 credits) of a doctoral program, has completed his research on campus, and has permission from the Dean to complete his work off campus, he need not register for credits. Similarly, a student who has earned 90 credits, but who still has much research to do, which does *not* involve using University facilities, and who receives permission to complete his work at, say, the Library of Congress, need not register. On the other hand, a student who uses University facilities for all his research must be registered for credit at all times, regardless of the number of credits that may accrue before he completes his work.

A candidate need not register during the semester in which he is to be graduated if he has met earlier all requirements for the degree with the exception of his final examination.

A resident student is required to register in person, not by proxy. A nonresident student is expected to assume responsibility for initiating the registration process but the details can be handled by mail. A student must register for courses audited as well as for those taken for credit.

For each registration the student, in consultation with his adviser, prepares a schedule of courses and research designed to fit his individual needs, which is then



submitted to the Dean of the Graduate School for his approval. The registration process is then completed in the manner specified for all students at the University.

Under certain conditions credit may be earned by work done off the campus. A student contemplating such work should inquire of the Dean of the Graduate School about the procedures and conditions. Such work must be scheduled *in advance* in the regular manner.

Registration dates are given in the University Calendar and a fee is assessed for the privilege of late registration. In any case, registration must be completed within the first two weeks of a semester or within the first one-sixth of any summer session. All changes of schedule must also be completed within this period, except that a student may drop a course at any time within the first four weeks of a semester. A student who is granted permission to register after the beginning of classes will, in general, be required to take a reduced load.

**AUDITING AND VISITING CLASSES**—A regularly registered graduate student who wishes to take a course without credit may be allowed to do so upon securing the permission of the instructor in the course and the approval of the Dean of the Graduate School. Such a student, known as an auditor, may, if he wishes, participate in class discussion, do practicum work, submit written work, and take examinations. He must register for the course in the same manner as if he were taking the course for credit and must pay fees on the same basis. He receives no grade in the course and cannot subsequently claim any sort of credit for work done in the course.

Ordinarily, a student is required to count the courses audited as a part of his graduate load. However, a student who has demonstrated his ability to do superior work while carrying a normal graduate program (as determined by his status as a full-time student, or as a part-time student employed on the campus or elsewhere) may, with the approval of the Dean, register for audits in addition to his credit load. To secure such approval the student should present to the Dean written evidence that the instructor of the "audit course" will accept him as an auditor, and that his adviser and the head of the department employing him (if any) approve of the extra load.

A regularly registered student of the Graduate School may at any time during the academic year visit, with the permission of the instructor, a class for which he is not registered. During summer sessions he must also obtain the permission of the Director of Summer Sessions. Under this provision the student may not claim the usual privileges of class membership, such as participating in class discussion, doing practicum work, submitting written work, and taking examinations. This privilege is officially designated as "visiting classes without registration."

**ACADEMIC LOAD**—A full-time student is one who devotes "all" his time to studies and/or research, and very little, if any, time to work for financial compensation. The normal maximum full-time credit load is 15 credits per semester, or 1 credit per week in shorter terms such as summer sessions. Larger loads may be scheduled very rarely and only with the approval of the Dean of the Graduate School. Ordinarily a student employed for more than a few hours per week may not register for 15 credits per semester, or 1 credit per week.

The University takes the position that the facilities of the Graduate School should be made available only to the student who can profit from his graduate school experience to a maximum extent. Therefore the Graduate School reserves the right to deny admission or registration to part-time students who (a) propose schedules of few credits which seem to reflect little real interest in graduate work or would not seem to require serious effort, or (b) wish to carry overloads of such proportions as to handicap them seriously in achieving maximum quality in their graduate work.

## GRADING SYSTEM

A part-time student who is a graduate assistant or an employee of the University is governed by the following load schedules:

EMPLOYMENT OR SERVICE LOAD		CREDIT LOAD ALLOWED	
<i>Hours per Week</i>	<i>Fraction of Full Time</i>	<i>Credits</i>	<i>Fraction of Full Load</i>
0	0	15	5/5
10	1/4	11-13	4/5
20	2/4	8-10	3/5
30	3/4	6-8	1/2
40	4/4	6	2/5

The considerations leading to the establishment of this "protective" schedule of permitted loads for assistants and employees apply equally to part-time students employed off-campus.

**STATUS UNDER SELECTIVE SERVICE**—As soon as an applicant has been admitted to the Graduate School, his local board will be informed *provided* the applicant requests it and has given the necessary information. As soon as he receives notification of admission, the applicant should check with the Associate Registrar to see that everything is in order.

A student is certified to be a full-time student insofar as Selective Service is concerned if he schedules at least 12 credits in a semester, if he holds an appointment as a quarter-time or half-time graduate assistant, or if he is serving an internship under approved conditions.

Whenever a student changes his status so as no longer to be considered a full-time student, fails to make satisfactory progress, or makes a drastic change in his declared goal, his local board will be notified.

**GRADING SYSTEM**—A grade is given to a student solely on the basis of the instructor's judgment as to his scholarly attainment.

For graduate courses (500 series) one of three grades may be given:

H for Honors, indicating definitely superior attainment.

P for Pass, indicating acceptable but not superior attainment.

F for Fail, indicating failure to attain the minimum standards of work acceptable for credit in a degree program.

For research or thesis one of four grades may be given:

H for Honors, indicating definitely superior attainment.

P for Pass, indicating acceptable but not superior attainment.

F for Fail, indicating failure to spend an appreciable amount of time doing the scheduled work or failure to attain the minimum standards of work acceptable for credit in a degree program.

R for Research, indicating that the investigation is continuing and that the student has devoted an adequate amount of time to the work scheduled but that the supervisor does not want to give a quality grade (H, P, or F) at this point. When the project is completed an H, P, or F must be given and will be considered the quality grade for the entire research. Grades of R given while the research was in progress will remain on the student's record permanently.

For 400 series courses one of five grades may be given:

<i>Grade</i>	<i>Percentage Equivalent</i>	<i>Grade Point Equivalent</i>
A	90-100	4
B	80- 89	3
C	70- 79	2
D	60- 69	1
F (Failure)	0- 59	0

Grades below B do not carry graduate credit and are considered failures in the program of a graduate student.

**GRADUATION**—It is the responsibility of the student to fill out a diploma card and pay thesis fees at the beginning of the semester or session when he expects to receive an advanced degree.

Degrees are normally granted at the end of each semester and at the end of the Main Summer Session.

All degrees conferred are tentative until final grade reports have been received even though the student's name may have appeared in the printed commencement program.

Attendance at commencement exercises is an obligation on the part of those receiving advanced degrees. A request to receive the degree *in absentia* may be presented to the Dean of the Graduate School, but only under extraordinary circumstances will it be granted.

## F E E S   A N D   L I V I N G   A C C O M M O D A T I O N S

### REGULAR FEES, PAID EACH SEMESTER:

#### *Students registered for 12 or more credits:*

Residents of Pennsylvania . . . . .	\$175.00
Nonresidents of Pennsylvania, on-campus studies . . . . .	375.00
Nonresidents of Pennsylvania, off-campus research (610) . . . . .	175.00

#### *Students registered for fewer than 12 credits:*

Residents of Pennsylvania, per credit . . . . .	15.00
Nonresidents of Pennsylvania, on-campus studies, per credit . . . . .	32.00
Nonresidents of Pennsylvania, off-campus research (610), per credit . . . . .	15.00

#### *Vocational education courses:*

Total charge for vocational education courses, indicated by "v" following the course number . . . . .	20.00
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#### *Graduate assistants, fellows, and scholars:*

Health and welfare charge . . . . .	20.50
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### SPECIAL FEES, PAID AS OCCASION DEMANDS:

#### *Applicable to all students, including graduate assistants, fellows, and scholars:*

Admission to the Graduate School . . . . .	10.00
Privilege of late registration or late payment . . . . .	10.00
Change of schedule, each change . . . . .	2.00
Microfilming of doctoral thesis and publication of abstract . . . . .	35.00



## LIVING ACCOMMODATIONS

Minimum fee for binding of thesis, per copy . . . . .	3.00
Official transcript of record (with seal), each copy . . . . .	1.00

The University reserves the right to revise fees without further notice.

Fees are the same for audit courses as for those scheduled for credit.

Summer sessions students who register for graduate courses pay the regular fees for the summer sessions.

Whenever it shall appear from any of the information presented as part of the application for admission that the applicant is not domiciled in Pennsylvania, the Dean of Admissions, when admission is granted to that applicant, assumes that the one admitted is a nonresident of Pennsylvania and includes that admission as a part of the established out-of-State quota. If the student who is thus admitted believes that his circumstances do not justify his classification as a nonresident of Pennsylvania, he may petition the Dean of Admissions for reclassification.

Whenever a petition for reclassification is made, the petitioner is required to present proof of bona fide continuous domicile of the one admitted (or of his parents, if he is a minor) within the Commonwealth for a period of not less than 12 months immediately preceding the date of such petition for reclassification; and, in addition, such other evidence as may appear pertinent to a complete review of his classification.

Whenever a student changes his domicile during his attendance at the University, such a student is subject to immediate reclassification by the Dean of Admissions.

Any student who does not fulfill payment obligations promptly may be charged \$1 for each day of delinquency up to and including five days, or a maximum of \$10 if the delinquency exceeds five days. A student whose account is delinquent for more than 10 days is subject to suspension from the University.

**HEALTH CENTER**—Graduate assistants, fellows, holders of graduate scholarships, and students who schedule 12 or more credits are entitled to 7 days' free treatment in the University Hospital by the University Health Center staff each semester. A nominal charge of \$3 is made for each day of hospitalization in excess of 7 days in any given semester. Almost all modern drugs are furnished free of charge as required for treatment, but the student may be charged extra for medication where such treatment is unusual or extremely expensive. Consult the *Manual for Graduate Students* for details concerning facilities and services.

**LIVING ACCOMMODATIONS**—A variety of living accommodations are available including rooms in private homes, lodging houses, and to a limited extent in University residence halls. Boarding houses and restaurants are available for meals. The cost varies considerably depending upon the type of accommodations. A list of known vacancies is maintained by the offices of the Dean of Men and the Dean of Women and by the Graduate Student Association. The prospective student should write to the appropriate office well in advance of the beginning of school because it may be very difficult to find a convenient location at the last minute.

A married student may find accommodations in apartments, trailers, and rooms in private homes. Personal contact is essential, but assistance may be gained through contact with the office of the Dean of Men or an advertisement in the local newspaper.

A limited number of married students may be admitted to Eastview Terrace, a housing development consisting of small one- and two-bedroom unfurnished units located on the campus. Applications are considered in the order in which they are received. For details write to the Director of Housing, Old Main.

## STUDENT AIDS AND SERVICES

**ASSISTANTSHIPS**—A number of graduate assistantships are available to students who show promise of superior ability to carry on graduate study. An appointee may serve as an assistant in classroom or laboratory instruction, or in research or office work. Exemption from all major fees and charges is granted, but the student must pay the health and welfare charge as well as such specific fees as admission, late registration, and change of schedule. Privileges for a graduate assistant appointed for the academic year do not extend into any of the summer sessions. A veteran holding a quarter-time or a half-time assistantship is eligible for full benefits from the Veterans Administration under Public Law 550.

An appointee may not accept additional employment, either at the University or elsewhere, during the period for which service to the University is required under the appointment. Vacation for a graduate assistant consists of the regular student vacations available to graduate students.

A student holding a quarter-time or a half-time assistantship is considered to be following a full-time course of instruction under Selective Service regulations and is certified to his local draft board as a full-time student. A student holding a three-quarter-time assistantship is not considered to be following a full-time course of instruction.

A prospective student should write directly to the head of his major department for information and application forms. Appointments are made upon the recommendation of the department head, subject to admission to the Graduate School and to the approval of the Dean of the Graduate School. Clear evidence of superior ability and promise is required. Reappointment to an assistantship requires a continuing demonstration of good scholarship.

The three types of graduate assistantships vary in stipend, service required, and the number of credits for which the student may register. Not all types will be available in every department.

**QUARTER-TIME**, requiring about 10 hours of service per week.

For the academic year: stipend \$603-\$801; 11-13 credits per semester.

For the fiscal year: stipend \$804-\$1068; 11-13 credits per semester, 8-9 credits in summer sessions.

**HALF-TIME**, requiring about 20 hours of service per week.

For the academic year: stipend \$1206-\$1602; 8-10 credits per semester.

For the fiscal year: stipend \$1608-\$2136; 8-10 credits per semester, 6-8 credits in summer sessions.

**THREE-QUARTER-TIME**, requiring about 30 hours of service per week.

For the academic year: stipend \$1809-\$2403; 6-8 credits per semester.

For the fiscal year: stipend \$2412-\$3204; 6-8 credits per semester, 4-6 credits in summer sessions.

**COUNSELORSHIPS**—A number of appointments are available to male students to serve as resident counselors in the undergraduate residence halls for men. A counselor's responsibility is to work for the social, academic, and emotional adjustment of the undergraduate residents. Specialized training in personnel work is desirable, though not essential.

These appointments are for the academic year and carry with them remission of fees for room and board, but not exemption from academic fees, except that all counselors pay the same fees as would residents of Pennsylvania.



## FELLOWSHIPS

Applications and requests for information should be addressed to the Dean of Men.

**FELLOWSHIPS**—Approximately 90 fellowships are awarded annually. Recipients must be superior students and are frequently required to have completed a certain minimum of graduate work before being eligible for an award. Fellows carry a full-time graduate program, receive a stipend which varies with the award, and have their fees paid by the grantor of the fellowship, or are exempted from the payment of all major fees by the University, as the case may be. They may not accept employment during the term of their appointment, nor are they required to render any service to the University. In some cases a fellow will be expected to limit his research to a broad field specified by the donor of the fellowship. Fellows are required to pay the health and welfare charge and other specific fees such as admission, late registration, and change of schedule.

Eleven fellowships, each providing a stipend of \$2000 for the academic year, are designated as Graduate School Fellowships. They are available to outstanding advanced graduate students in any field, although preference is given to applicants majoring in the humanities and social sciences. Information and application forms may be secured from the Dean of the Graduate School.

Approximately 80 fellowships, with various stipends, are awarded through the individual departments. Information and application forms may be secured from the head of the major department concerned. The fellowships which are awarded will vary somewhat from year to year, but the following are typical of those which were available for 1957-58:

**ALLEGHENY LUDLUM FELLOWSHIP**—Open to graduate students in metallurgy for studies in steelmaking.

**ALLIED CHEMICAL AND DYE FELLOWSHIP**—Open to graduate students in chemical engineering.

**ALLIED CHEMICAL AND DYE FELLOWSHIP**—Open to graduate students in organic chemistry for the final year of study leading to the Ph.D. degree.

**AMERICAN LITHIUM INSTITUTE FELLOWSHIP**—Open to graduate students in ceramic technology for studies of glass systems containing lithium.

**AMERICAN PETROLEUM INSTITUTE FELLOWSHIPS (8)**—Open to graduate students in chemistry and physics for research concerning the synthesis and properties of high molecular weight hydrocarbons.

**CARNEGIE GRADUATE FELLOWSHIPS (3)**—Open to advanced level graduate students.

**CONTINENTAL OIL COMPANY FELLOWSHIP**—Available to graduate students in petroleum and natural gas engineering for studies in petroleum engineering.

**CO-OPERATIVE GRANGE LEAGUE FEDERATION FELLOWSHIPS (2)**—For research in poultry nutrition and in egg quality, with major interest in biochemistry.

**CO-OPERATIVE PROGRAM FELLOWSHIP**—Open to graduate students in metallurgy.

**CORNING GLASS WORKS FOUNDATION FELLOWSHIP**—In support of graduate work on glass or any of its components.

**CURTISS-WRIGHT CORPORATION FELLOWSHIP**—Open to graduate students in aeronautical engineering, electrical engineering, mechanical engineering, and engineering mechanics.

**DANFORTH FOUNDATION FELLOWSHIPS**—For graduate students in the natural sciences, social sciences, humanities, and other fields of specialization preparing themselves for college teaching, who see in teaching a vocation of Christian service.



DAVISON CHEMICAL COMPANY FELLOWSHIP—Open to graduate students in mineral preparation engineering.

DEVEREUX FELLOWSHIP—Open to selected graduate students in clinical psychology.

DOW CORNING FELLOWSHIPS—Open to graduate students in chemistry for fundamental studies in organosilicon compounds.

DU PONT POSTGRADUATE FELLOWSHIP—Open to graduate students in mechanical engineering and engineering mechanics.

DU PONT POSTGRADUATE TEACHING FELLOWSHIP IN CHEMISTRY—Open to graduate students in chemistry for the final year of study leading to the Ph.D. degree.

EASTMAN KODAK FELLOWSHIP—Open to graduate students in chemistry for the final year of study leading to the Ph.D. degree.

ELLIOTT FELLOWSHIP IN ENGINEERING RESEARCH—An annuity provided by W. S. Elliott of Pittsburgh for a graduate student in engineering.

ESSO RESEARCH AND ENGINEERING POSTGRADUATE FELLOWSHIP IN CHEMISTRY—Open to advanced graduate students in the Department of Chemistry for one year of study leading to the Ph.D. degree.

FOUNDRY EDUCATIONAL FOUNDATION FELLOWSHIP—Open to graduate students in mechanical engineering, industrial engineering, and metallurgy who have demonstrated interest in foundry technology.

GENERAL ELECTRIC FELLOWSHIP—Open to graduate students in metallurgy.

GENERAL FOODS FELLOWSHIP—Open to graduate students in any major in home economics.

GULF COMPANY FELLOWSHIP IN PETROLEUM AND NATURAL GAS ENGINEERING—In support of graduate work in petroleum and natural gas engineering for studies in petroleum production.

HALOID FELLOWSHIP IN PHYSICS—In support of graduate work in the field of solid state physics.

HAMILTON STANDARD FELLOWSHIPS (3)—Open to graduates of this University in aeronautical engineering, electrical engineering, and mechanical engineering.

HEYL AND PATTERSON FELLOWSHIP—Open to graduate students in mineral preparation engineering.

HUMAN FACTORS RESEARCH PROGRAM FELLOWSHIP—Open to graduate students in the Department of Psychology for the final year of study leading to the Ph.D. degree.

JONES AND LAUGHLIN STEEL CORPORATION FELLOWSHIP in refractories.

KAISER ALUMINUM AND CHEMICAL CORPORATION FELLOWSHIP—Open to students in the Department of Ceramic Technology for studies in refractories.

KENNECOTT COPPER CORPORATION FELLOWSHIP IN GEOPHYSICS—Open to graduate students in geophysics for studies relating to mining geophysics.

LITHIUM CORPORATION OF AMERICA FELLOWSHIP—Open to graduate students in ceramic technology for studies in inorganic lithium compounds and lithium oxide systems.

NATIONAL CARBON DIVISION OF UNION CARBIDE AND CARBON CORPORATION FELLOWSHIP—In support of graduate work on carbon and related materials or in the field of solid state physics.

NEW YORK LIFE INSURANCE COMPANY FELLOWSHIP—Open to graduate students in insurance.

## FELLOWSHIPS

EDWARD ORTON, JR., CERAMIC FOUNDATION FELLOWSHIP—Open to graduate students in ceramics for studies relating to kiln-fired ceramic bodies.

PAN-AMERICAN FELLOWSHIP IN PETROLEUM AND NATURAL GAS ENGINEERING—Open to graduate students in petroleum and natural gas engineering for studies in petroleum production.

PENNSYLVANIA BANKERS ASSOCIATION FELLOWSHIP—Open to graduate students in money and banking.

PENNSYLVANIA CO-OPERATIVE WILDLIFE RESEARCH FELLOWSHIPS (3)—Funds supplied by the Pennsylvania Game Commission for investigations dealing with wildlife management.

PENNSYLVANIA NATURAL GAS MEN'S FELLOWSHIP—Available to graduate students in petroleum and natural gas engineering for studies in gas technology.

PITTSBURGH PLATE GLASS FELLOWSHIP—Open to graduate students in ceramic technology for fundamental studies of glass.

ROCHESTER AND PITTSBURGH COAL FELLOWSHIP—Open to graduate students in mining engineering.

SHELL COMPANY FELLOWSHIP IN CHEMICAL ENGINEERING—In support of graduate work in chemical engineering, preferably for students in their last year of doctoral work.

SHELL COMPANY FELLOWSHIP IN CHEMISTRY—Open to graduate students in the Department of Chemistry for the final year of study leading to the Ph.D. degree.

SPEER CARBON FELLOWSHIP—Open to graduate students in fuel technology for studies on carbon.

SPERRY GYROSCOPE COMPANY FELLOWSHIP—Open to graduate students in electrical engineering.

SPRAGUE ELECTRIC COMPANY FELLOWSHIP—Open to graduate students in ceramic technology for studies in the field of ceramic dielectrics.

STACKPOLE FELLOWSHIP IN METALLURGY—Open to graduate students in metallurgy for studies in powder metallurgy.

STACKPOLE CARBON FELLOWSHIP—Open to graduate students in ceramic technology for studies in the field of ceramic ferrite materials.

STEARNS MAGNETIC, INC., FELLOWSHIP—Open to graduate students in mineral preparation engineering.

L. L. STEARNS AND SONS FELLOWSHIP—Open to graduate students in retailing.

ST. JOSEPH LEAD COMPANY FELLOWSHIP—Open to graduate students in metallurgy for studies in chemical metallurgy.

SYLVANIA FOUNDATION FELLOWSHIP—Open to graduate students who wish to do research in metallurgy, ceramics, or solid materials related to the electronics industry.

TITAN METAL FELLOWSHIP IN METALLURGY—Open to graduate students in metallurgy for studies on copper-base alloys.

UNION CARBIDE CORPORATION FELLOWSHIP IN CHEMISTRY—Open to graduate students in chemistry for the final year of study leading to the Ph.D. degree.

UNION CARBIDE AND CARBON FELLOWSHIP—Open to graduate students in the College of Mineral Industries.

UNITED STATES DEPARTMENT OF HEALTH, EDUCATION AND WELFARE TRAINEESHIPS IN VOCATIONAL REHABILITATION COUNSELING—Open to graduate students in the Department of Education specializing in rehabilitation counseling.



UNITED STATES PUBLIC HEALTH SERVICE FELLOWSHIPS (TRAINEES)—Open to selected graduate students in clinical psychology.

UNITED STATES STEEL FOUNDATION FELLOWSHIP—Open to graduate students in the College of Mineral Industries for studies related to steel-making.

VETERANS ADMINISTRATION INTERNSHIPS (23)—Open to students in clinical or counseling psychology.

YOUNGSTOWN SHEET AND TUBE COMPANY FELLOWSHIP—Open to graduate students in mining engineering.

In addition, numerous grants are available from governmental agencies, industrial concerns, and foundations for the support of investigations of particular problems. Many of these permit full-time study and carry the same fee exemptions as the fellowships listed above. Detailed information may be secured from departments.

Among these are the National Science Foundation Predoctoral Fellowships for graduate study in physical sciences, mathematics, biological sciences, earth sciences, psychology, anthropology, and areas where natural sciences converge with social sciences. These fellowships are used at the university of one's choice, and application should be made to the National Science Foundation, Washington 25, D. C.

JOHN W. WHITE FELLOWSHIPS—Awarded to two graduates of The Pennsylvania State University each year on the basis of scholarship, need, character, and attitude. The recipients may enroll in any approved college or university.

SCHOLARSHIPS—A number of scholarships are awarded annually. Applications should be addressed to the Dean of the Graduate School and must be received by March 1 in order to be considered for the following academic year.

GRADUATE SCHOLARSHIPS—Forty are awarded each year. These scholarships carry no stipend but do grant exemption from all major fees. Recipients are required to take a full program of graduate work and may be required to render some service.

A.A.U.W. SCHOLARSHIP—The State College Branch of the American Association of University Women has established a scholarship for a woman graduate student. The amount of the award varies and does not include fee exemption.

LOAN FUNDS—Funds are available for limited loans. Applications should be addressed to the Dean of Men or the Dean of Women.

STUDENT EMPLOYMENT—Many students depend partly on their own earnings to help meet their expenses. The Student Employment Office, 112 Old Main, gives information on part-time jobs. A student not holding an assistantship, fellowship, or scholarship who wants a part-time job should register with the Student Employment Office as soon as his class schedule has been arranged. While some students find regular part-time work, many of them depend on a series of odd jobs, some of which are of a continuing nature.

VETERANS BENEFITS—The Co-ordinator of Veterans Affairs is charged with the responsibility of handling all applications for benefits under the various Public Laws.

Under P.L. 550 the responsibility for classifying students as to their rate of training rests with the Dean of the Graduate School. The classification is based on the extent to which the student devotes himself to his graduate program (as contrasted with the service for which he receives remuneration) and is not directly determined by the number of credits scheduled. Thus a student who is employed about 20 hours per week and devotes the remainder of his time to graduate work would be considered a half-time student on the basis of his employment regardless of how



## SERVICES

many credits he was permitted to schedule. However, a quarter-time or a half-time graduate assistant is considered to be a full-time student insofar as benefits under P.L. 550 are concerned.

**PLACEMENT SERVICE**—The University Placement Service is designed to coordinate the placement activities of all the Colleges and the Graduate School. The services of the following divisions are available to the student without charge.

The Placement Service functions primarily as a clearing house, bringing together students, alumni, faculty members, and representatives of organizations that are seeking college-trained personnel. Summer jobs other than those at camps or resorts are listed at this office.

The Teacher Placement Division assists seniors, alumni, and graduate students in all departments in securing teaching positions for which they are qualified.

The Student Employment Division offers assistance to students in finding part-time employment in town and on the campus, as well as summer employment at camps and resorts. A student must be registered to be informed of jobs.

These divisions are available to any student, regardless of level, who is in need of counseling or guidance on employment problems.

**RELIGIOUS PROGRAMS**—The University seeks to serve the spiritual needs of its students and staff. General responsibility for religious activity on the campus rests with the University Chaplain and Co-ordinator of Religious Affairs. Individual organizations under the sponsorship of members of the Jewish, Protestant, and Roman Catholic faiths serve the student body. Many other religious organizations, including denominational and interdenominational groups, are active on the campus and in association with local churches.

**STUDENT AFFAIRS**—The Graduate Student Association is the official University-wide organization of graduate students. All students enrolled during the academic year have membership in the Association, which promotes the general welfare and the academic interests of graduate students. It publishes the *Graduate School Newsletter*, maintains an up-to-date list of housing for graduate students, helps to sponsor the Graduate School lecture series, and sponsors social functions.

**SUMMER SESSIONS**—A series of sessions covering a total period of 12 weeks are arranged each summer. During this time there are excellent opportunities for graduate work in many fields. Detailed information can be secured from the *Summer Sessions Complete Announcement*, which is published about April 1 and may be obtained by writing to the Dean of Summer Sessions.

It is the aim of the University to make available its staff and resources during the summer to aid students to the fullest possible extent in their programs of graduate study and research. The University cannot guarantee, however, that all the services normally offered during the academic year will be at hand during the summer.

To avoid disappointments, a student who plans to present a thesis for final consideration or to take the final doctoral examination during the summer sessions should inform the chairman of his committee and the head of his department of his intentions prior to June 1. A notice of approval will be sent to the student if the necessary staff members will be available to provide the service requested.

A graduate student desiring to carry forward a special graduate program or research project not officially listed as a part of the summer sessions should, likewise, obtain written approval of his plans from the chairman of his committee and the head of his department prior to June 1.

## ACADEMIC DEGREES

## MASTER OF ARTS AND MASTER OF SCIENCE

These two degrees have similar requirements and the particular degree conferred upon the student is determined by the general area of his major field.

**ADMISSION**—Adequate undergraduate preparation is required in the field in which the applicant expects to pursue advanced work. The specific courses and the total number of undergraduate credits required in various areas will be determined by the choice of field and can be ascertained from the Dean of the Graduate School. An applicant who meets the minimum grade point average but is deficient in course preparation may, under certain circumstances, be admitted to the Graduate School and allowed to make up the undergraduate deficiencies. Under these circumstances the program will require more than the minimum period of residence.

**REQUIREMENTS**—A program for the master's degree requires a minimum of 30 credits and consists of a major and either a minor or a group of general studies. A minor consists of no fewer than 6 credits of integrated or articulated work in one field related to but different from that of the major. A general studies group consists of no fewer than 6 credits in fields other than that designated as the major field considered by the major department to have significance and value for the candidate.

The program requires the equivalent of at least one academic year (two semesters), and may be met by full-time residence, part-time work, attendance in the summer sessions, or by any combination of these. Many students find that adequate programs leading to the master's degree involve considerably more than 30 credits and require more than one year's work. Ten credits earned in residence at another approved institution or in the off-campus classes of The Pennsylvania State University may, under certain conditions, be offered in partial fulfillment of the requirements. All requirements, whether satisfied here or elsewhere, must be met within six years, or a period spanning seven consecutive summers.

A minimum of 12 credits in course work, as contrasted with research, must be completed in the major field and at least 6 credits in addition must be devoted to a thesis. At least 18 credits in graduate courses (500 series) and thesis research combined must be offered toward the fulfillment of minimum requirements for the degree. A student's program must be approved by his adviser and the Dean of the Graduate School.

In addition to the above general requirements, a major department may set up specific course and subject-matter requirements for students working in its area.

The mere completion of a stated amount of work does not entitle a student to recommendation for a degree. He must pass examinations upon such subjects and at such times as shall be designated by the departments concerned and must present an acceptable thesis.

**THESIS**—Under the direction of the department in which the student's major subject is taken, he must prepare a thesis upon a suitable topic related to that subject. Under certain conditions a student may be permitted to complete the thesis *in absentia*. To obtain such permission he must make satisfactory arrangements in advance with both the major department and the Dean.

A copy of the *Thesis Information Bulletin*, containing detailed regulations concerning format, paper, illustrations, etc., may be obtained at the Graduate School office.



## DOCTOR OF PHILOSOPHY

The degree of Doctor of Philosophy is conferred in recognition of high attainment and productive scholarship in some special field of learning as evidenced by (1) the satisfactory completion of a prescribed period of study and investigation, (2) the preparation of a thesis involving independent research, and (3) successfully passing examinations covering both the special subject and the general field of learning of which this subject forms a part.

**RESIDENCE REQUIREMENTS**—A candidate must earn at least 30 credits in residence at The Pennsylvania State University in regular semesters. During at least two semesters, if he be a part-time student, the candidate is expected to limit his work load to half-time at most and to devote the balance of his time to his graduate program. A minimum of three academic years of full-time graduate study and research, or their equivalent in credits, is required for the attainment of a doctor's degree. The equivalent of two academic years may be secured by residence at another approved institution, or by a combination of one year at another institution and one year of off-campus research. Even though two years of advanced standing be granted, it is usually impossible to meet course, examination, and thesis requirements within the period of one academic year on this campus.

Subject to the approval of his adviser, the head of his major department, and the Dean of the Graduate School, a student may register for research to be done off-campus. Such work will not be approved, however, simply because the arrangement is convenient for the student; scholarly considerations must determine the choice of location.

**PROGRAM**—There is no specified number of courses or credits the earning of which will guarantee the attainment of the doctor's degree. The program shall consist of such a combination of courses and research as is approved by the doctoral committee for each individual student, and includes a major and either a minor or a general studies group. Approximately two-thirds of the total time is to be devoted to the major field. A minor consists of no fewer than 15 credits, including those applied toward the master's degree, of integrated or articulated work in one field related to but different from that of the major. A general studies group consists of no fewer than 15 credits, including those applied toward the master's degree, in fields other than that designated as the major field and considered by the major department to have significance and value for the candidate.

The first year of graduate study leading to the doctor's degree may be substantially the same as that provided for the master's degree and may lead to that degree, although that is not necessary.

After one year of acceptable graduate work, either here or elsewhere, a student may be admitted to candidacy for the doctor's degree, provided that he has satisfied the major department (in the manner indicated below) that he is prepared to proceed.

**CANDIDACY AND EXAMINATIONS**—A student expecting to become a candidate for the degree of Doctor of Philosophy must present himself for a doctoral candidacy examination near the end of the first, or at the beginning of the second, year of graduate work (including work done for the master's degree and work done elsewhere as well as here; i.e., at about the time he has earned a total of 30 graduate credits). A new student transferring from another graduate school with 30 or more transfer credits must take this examination before he has earned more than 10 credits here. Arrangements for the examination are made by the major depart-



ment. If the student passes the examination, and in the opinion of the graduate faculty of his major department is qualified to follow a doctoral program, he is admitted to candidacy.

After a student has been admitted to candidacy the Dean upon recommendation of the head of the major department will appoint a doctoral committee which will thereafter guide him in candidacy.

For the Doctor of Philosophy degree, candidates are required to have a reading knowledge of at least two foreign languages. German and French are the languages most often needed. Other languages may be presented instead of these if their choice is determined by scholarly and professional reasons. The choice of a language must be approved by the major department. If a language other than English, French, German, Italian, Spanish, or Russian is presented, it must be approved also by the Dean of the Graduate School. A student may not present his mother tongue as one of the two languages required in candidacy. Candidates may present certification of having passed equivalent language examinations in other institutions in lieu of repeating the examinations. For further details, see the *Manual for Graduate Students*.

When a doctoral candidate has substantially completed his course work, he will be given a comprehensive examination covering his major and minor fields to determine whether he has adequate mastery of the subject matter to entitle him to proceed to the completion of a thesis. The candidate must have satisfied the language requirements before taking this examination.

A doctoral candidate who has satisfied all other requirements for the degree will be scheduled, on recommendation of the doctoral committee, to take a final examination. In no case may the final examination be scheduled less than three months after the comprehensive examination. The final examination is oral, open to the public, related in large part to the thesis, but may cover the whole field of study of the candidate without regard to courses that have been taken either here or elsewhere.

**THESIS**—The ability to do independent research and competence in scholarly exposition must be demonstrated by the preparation of a thesis on some topic related to the major subject. It should represent a significant contribution to knowledge, be presented in a scholarly manner, reveal on the part of the candidate an ability to do independent research of high quality, and indicate considerable experience in using a variety of research techniques. The contents and conclusions of the thesis must be defended at the time of the final examination.

The completed thesis together with an abstract, typewritten in triplicate, must be filed in the office of the Dean of the Graduate School not later than two weeks prior to the commencement at which the candidate expects to receive the degree.

A copy of the *Thesis Information Bulletin*, containing detailed regulations concerning format, paper, illustrations, etc., may be obtained at the Graduate School office.

## PROFESSIONAL DEGREES

### MASTER OF EDUCATION

The degree of Master of Education represents general scholarship, acquaintance with the chief phases of educational literature, teaching skill, qualities of leadership in educational work, and ability to solve concrete problems in at least one special field of educational activity.

## MASTER OF EDUCATION

**ADMISSION**—An applicant is required to have had at least 27 undergraduate credits in the field of education, including practice teaching, except that under certain circumstances this rule may be waived for a student working for the Doctor of Education degree with a major in higher education. An applicant choosing a major outside the fields of education (such as mathematics, geography, or history) will be expected to have in addition an adequate undergraduate preparation in the field of specialization. The specific course requirements and the total number of undergraduate credits required in the various areas will be determined by the choice of field. An applicant who meets the minimum grade point average for admission but is deficient in course preparation may, under certain circumstances, be admitted to the Graduate School and allowed to make up the undergraduate deficiencies. Under these circumstances the program will require more than the minimum period of residence.

**REQUIREMENTS**—A minimum of 30 credits is required, of which 6 may be granted for an approved thesis. The program requires the equivalent of one academic year (two semesters) and may be met by full-time residence, part-time work, attendance in the summer sessions, or any combination of these. Ten credits earned in residence at another approved institution or in off-campus classes of The Pennsylvania State University may, under certain conditions, be offered as partial fulfillment of the requirements. All requirements, whether satisfied here or elsewhere, must be met within six years, or a period spanning seven consecutive summers.

A minimum of 24 credits must be earned in graduate course work. The larger part of this work shall be in courses open only to graduate students, but the needs of the student shall be considered in arranging the best combination of courses (400 and 500 series) for the preparation of the candidate in his special field. The degree program must be approved by the student's adviser or advisory committee.

When the student chooses a group major, his study program will be approved by a standing committee (or its representatives), which committee will foster the student's interests and stand in the same relation to him as does a department in the case of a student with a specific major. Such standing committees have been appointed in the broad fields of biological science, physical science, and social studies.

Those candidates who do not elect to write a thesis are required to present an essay or term paper. It must be of considerable proportion, giving evidence of their capacity to describe a serious intellectual experience in writing, and giving unmistakable evidence of ability to formulate and state meaningfully the purpose of an investigation, study, critical analysis or evaluation, to acquire and analyze information, to draw conclusions logically, and to relate findings to professional problems and practices. The particular nature and extent of such a piece of writing (whether it be required in connection with a course or independently of course work), and when it is to be undertaken, shall be determined by the major department.

**MAJOR AND MINOR FIELDS**—If a student looks forward to a career as a teacher, he may choose a major outside the fields of education (such as English, mathematics, or geography) and take the majority of his work in that field. In this case the student is required to have a minor consisting of no fewer than 6 credits in basic education (includes specific courses in comparative education, educational measurements and statistics, educational psychology, history of education, and philosophy of education). If he can demonstrate by examination an adequate background in basic education, he may choose a minor in any field of education.

If a student wishes to work in a broader field, a group major such as social studies, physical science, or biological science may be chosen. In this case at least 24



credits are to be devoted to the group, and no fewer than 6 credits to a minor in basic education. It is expected that each student will choose one subject of the group as a field of primary interest, to which at least 12 credits are to be devoted.

If a student looks forward to a career as an administrator, a guidance counselor, or a supervisor, he may specialize in one of the fields of education and choose that as his major. In this case the student is required to have a minor consisting of no fewer than 6 credits in either a field outside of education or in basic education as defined above.

A candidate majoring in education is required to take a departmental qualifying examination, comprehensive in scope, before completing the second half of his course requirements. This serves as a guide in outlining a program of study that will fit his individual needs.

## DOCTOR OF EDUCATION

The degree of Doctor of Education is conferred in recognition of scholarship and teaching or administrative skill as evidenced (1) by the satisfactory completion of a prescribed period of study; (2) by the application of scientific principles in classroom teaching, in the supervision of instruction, or in administrative work; (3) by the preparation of a thesis demonstrating ability to undertake an educational problem with originality and independent thought; (4) by successfully passing examinations showing a satisfactory grasp of the field of specialization and its relation to allied subjects; and (5) by recognized leadership in the profession of education.

**RESIDENCE REQUIREMENT**—A candidate must earn at least 30 credits in residence at The Pennsylvania State University. This requirement may be met by attendance at summer sessions, although there is no guarantee that it will be possible to do so in all cases. A minimum of three academic years of full-time graduate study and research, or their equivalent in credits, is required for the doctor's degree. However, it is not required that the three years be continuous. Graduate study may be carried on through a longer period and paralleled by teaching or administrative work.

The equivalent of two full years of work may be secured by residence at another approved institution, or by a combination of one year at another institution and one year of off-campus research. Even though two years of advanced standing be granted, it is usually impossible to meet course, examination, and thesis requirements within the period of one academic year on this campus. Credit for courses and research work done elsewhere can be used to meet degree requirements only if appropriate to the candidate's proposed program of study as determined by his doctoral committee.

A doctoral candidate may register for a maximum of 30 credits of off-campus research to be done in the public schools or in other approved centers. The arrangement must be approved by the adviser, the head of the major department, and the Dean of the Graduate School in advance of registration. The maximum load permitted for a student who is fully employed is 6 credits in a semester and 5 credits in the summer.

**PROGRAM**—There is no specified number of courses or credits the earning of which will guarantee the attainment of the doctor's degree. The general requirements are based not upon courses or credits but upon a period of residence, a satisfactory thesis, the passing of comprehensive examinations, and possession of the qualities of professional leadership. A program shall consist of such a combination



## DOCTOR OF EDUCATION

of courses and individual study and research as is approved by the doctoral committee for each candidate. The program of study shall be so arranged as to lead toward high professional mastery within some area of educational service. A majority of the courses offered in fulfillment of the requirement must be in the major field of study.

A candidate choosing a major outside the fields of education (such as chemistry, English, or history) shall have a minor consisting of no fewer than 15 credits, including those applied toward the master's degree, in psychology and basic education (includes specific courses in comparative education, educational measurements and statistics, educational psychology, history of education, and philosophy of education).

A candidate choosing a major in one of the fields of education must also choose either a minor or a general studies group with the approval of the major department. In this case a minor consists of no fewer than 15 credits, including those applied toward the master's degree, in one field outside the fields of education. An acceptable general studies group consists of no fewer than 15 credits, including those applied toward the master's degree, in fields outside the fields of education considered by the major department to have significance and value for the candidate. Every candidate must show through comprehensive examinations that he is familiar with current theories of education, that he understands and can apply the techniques and the findings of educational research so far as they bear upon the teaching of his subject, that he is prepared to read understandingly and contribute to the technical and professional literature in his field, and that he can criticize his own procedures in the light of historical trends and practices in this and other countries. Command of the tools for a thorough study of the problems of education is necessary and must include familiarity with statistical methods. For certain students the requirements may include a reading knowledge of one or more foreign languages.

After one year of acceptable graduate work, either here or elsewhere, a student may be admitted to candidacy for the doctor's degree, provided that he has satisfied the major department (in the manner indicated below) that he is prepared to proceed.

**CANDIDACY AND EXAMINATIONS**—A student expecting to become a candidate for the degree of Doctor of Education must present himself for a doctoral candidacy examination near the end of the first, or at the beginning of the second, year of graduate work (including work done for the master's degree and work done elsewhere as well as here; i.e., at about the time he has earned a total of 30 graduate credits). A new student transferring from another graduate school with 30 or more transfer credits must take this examination before he has earned more than 10 credits here. Arrangements for the examination are made by the major department.

Three of the important factors taken into consideration in passing judgment upon admission to candidacy are:

1. Previous scholastic record at this institution and other institutions attended.
2. Achievement in candidacy examinations.
3. Estimates of the student's personal and professional qualifications by the graduate faculty of the major department.

After a student has been admitted to candidacy, the Dean, upon recommendation of the head of the major department, will appoint a doctoral committee which will thereafter guide him in candidacy.

When the candidate has substantially completed his course work, he will be given a comprehensive examination covering his major and minor fields to determine

whether or not he may proceed to the completion of his thesis. This examination will be designed to test (1) the candidate's general scholastic preparation and professional background, and (2) his ability to integrate and apply his knowledge in his fields of specialization to practical situations so as to reflect an intelligent mastery of the subjects.

A candidate who has fulfilled all other requirements for the degree will be scheduled, on recommendation of his doctoral committee, to take the final oral examination for the degree. The committee in charge of this examination will consist of the student's doctoral committee and others appointed by the Dean of the Graduate School. In no case may the final examination be scheduled less than three months after the comprehensive examination. The final examination will be based largely upon the thesis, but may cover the whole field of study of the candidate without regard to courses that have been taken either here or elsewhere.

**THESIS**—Evidence of a high degree of scholarship, competence in scholarly exposition, and ability to select, organize, and apply knowledge must be presented by the candidate in the form of a written thesis. The candidate must demonstrate capacity for independent thought as well as ability and originality in the application of educational principles or in the development of new generalizations under scientific controls. The topic and outline of the proposed thesis must have the approval of the doctoral committee.

The completed thesis together with an abstract, typewritten in triplicate, must be filed in the office of the Dean of the Graduate School not later than two weeks prior to the commencement at which the candidate expects to receive the degree.

A copy of the *Thesis Information Bulletin*, containing detailed regulations concerning format, paper, illustrations, etc., may be obtained at the Graduate School office.

## MASTER OF ENGINEERING

The program leading to the degree of Master of Engineering is designed to provide training for advanced professional competence in the several fields of engineering. It should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Science.

**ADMISSION**—In addition to meeting the general requirements for admission to the Graduate School, an applicant must have received a baccalaureate degree from an approved institution in either an accredited engineering curriculum or in some other program providing adequate training in mathematics, the physical sciences, and the engineering sciences to qualify him for professional engineering activity.

**REQUIREMENTS**—A minimum of 30 credits is required for the degree, and of these at least 12 must be earned in graduate courses (500 series). A minimum of 6 credits must be earned outside the candidate's field of concentration.

A scholarly written report on a developmental study involving at least one area represented in the candidate's course work is required as an integral part of the program. The report must be comparable in its level of work and quality to a graduate thesis.

No work for this degree is required to be done in residence provided the major department or supervisory committee agrees that a suitable program can be pursued off campus.



## MASTER OF FORESTRY

The degree of Master of Forestry represents scholastic ability, acquaintance with forestry literature, and technical knowledge of one or more of the several specialized fields in forestry or wood utilization. It is offered to provide an opportunity for additional study in a student's particular field of interest rather than for research work on a special problem, though such work is not precluded under the requirements for the degree.

**ADMISSION**—An applicant for admission is required to hold a baccalaureate degree, or its equivalent, from a recognized professional school of forestry. Full information concerning the preparation required in either general forestry or wood utilization is kept on file by the Admissions Officer of the Graduate School. If there are deficiencies at the time of admission, they must be removed early in the program.

**REQUIREMENTS**—A minimum of 30 credits is required for the degree of Master of Forestry. It is expected that the larger part of the program shall be in graduate courses (500 series), but no specific number of credits in the 500 series is required. A thesis representing a minimum of 6 credits must be prepared. Under certain conditions a student may be permitted to complete the thesis *in absentia*. To obtain such permission he must make satisfactory arrangements in advance both with the head of the department and with the Dean. All requirements, whether satisfied here or elsewhere, must be met within six years, or a period spanning seven consecutive summers.

A maximum of 10 credits earned in off-campus classes of The Pennsylvania State University or in resident classes of other approved institutions may, under certain conditions, be applied toward the degree provided they fit into the program of the student.

A student should choose one field of work for his major interest, with one or two related minor fields. The proportion of credits to be taken in the major and minor fields of study will be determined in consultation with the student's advisory committee.

## MASTER OF PUBLIC ADMINISTRATION

The program leading to the degree of Master of Public Administration is designed to provide pre-service training for students planning to enter the field of public administration at the national, state, or local level. It is a terminal program and cannot be applied toward a doctorate.

**ADMISSION**—An applicant must be admitted to the Graduate School and be approved by a departmental committee before entering upon the program. A class of limited size will be selected on the basis of scholastic records, occupational interest, and general qualifications. An all-University average of at least B is required. Selection will be largely from majors in liberal arts, business administration, and engineering.

**REQUIREMENTS**—The program covers a 12-month period and consists of two semesters of work on campus, followed by an internship of 6 weeks in some governmental agency. The course of study is made up of subject blocks, such as organization, management, personnel administration, budgeting, finance, accounting, public works administration, administrative law, planning, statistics, report writing,



speech, and public relations. The student has a major in public administration and a minor in either public finance or public works depending upon his interest.

In lieu of a thesis, the student is required to submit an extensive written report on a project which has been carried out during his internship.

The Institute of Local Government serves as the agent of the Department of Political Science for the purpose of administering the program.

## TECHNICAL DEGREES

The degrees conferred are Fuels Engineer, Ceramic Engineer, Engineer of Mines, Metallurgical Engineer, and Petroleum Engineer.

**ADMISSION**—A graduate of the College of Mineral Industries of The Pennsylvania State University may be admitted to work for a technical degree, provided he submits evidence of having been engaged for a period of not less than three years in acceptable professional work in the field in which the application for the degree is made.

A technical degree may also be granted to an engineer of approved practical experience who is a graduate in engineering of another institution of equal standing, on completion of at least three years of full-time teaching or research work in engineering in a professorial rank in this institution, and upon presentation of an acceptable thesis and the fulfillment of all other requirements for technical degrees.

An applicant for a technical degree must file with the Dean of the Graduate School an application filled out in duplicate on the prescribed forms, approved by the head of the department in which the undergraduate work was completed. The application should be accompanied by the admission fee of \$10.

**REQUIREMENTS**—Not less than three years shall have elapsed from the time of receiving the first degree before a graduate of this institution shall be permitted to file his application for a technical degree. The application for a technical degree shall include evidence of a satisfactory professional record, which must be approved by the executive committee of the undergraduate College concerned.

Registration for these degrees is the same as for resident students. A candidate must be registered during two regular semesters.

In order to be recommended for a technical degree, the candidate must prepare a thesis on a subject related to his profession, and he may be required to appear in person to defend his thesis.

**THESIS**—Immediately following registration the candidate must submit for approval an outline of his proposed thesis; and at least six weeks prior to the day on which the degree is to be conferred, the complete thesis must be in the office of the head of the department concerned.



# PROGRAMS AND COURSES

**PROGRAMS** of study leading to advanced degrees are offered in many major and minor fields. These are listed in the following section, and the major fields are summarized on page 50. Related courses are grouped together under the name of the field. To locate a particular field or group of courses consult the index.

In general, departments of the University are identified with specific major fields. Thus aeronautical engineering is a major field of study which is offered under the supervision of the Department of Aeronautical Engineering. On the other hand, biological science and comparative literature are major fields for which there are no corresponding departments. In such cases a committee of the Graduate School is responsible for administering the program. In some cases a single department offers work in more than one field. Thus the Department of Civil Engineering offers work in both civil and sanitary engineering.

Applicants for admission are encouraged to consult the person whose name is listed under the major field heading.

**DEGREES**—In those major fields approved for the doctorate the Ph.D. is normally conferred, although a program leading to the D.Ed. may also be arranged with the consent of the department or committee in charge if such a professional program is appropriate. Similarly in major fields approved for the master's degree the M.A. or M.S. is normally conferred, but a program leading to the M.Ed. or M.Eng. may also be available. The D.Ed. and M.Ed. are not limited to the fields of education, but with the consent of the department or committee in charge may be offered in any approved major field appropriate to the preparation of teachers, such as chemistry, English, etc. In this case the program is sponsored by a major department outside the fields of education, such as the Department of Chemistry, but the student's minor is in education.

**MINOR FIELDS**—All major fields listed are also acceptable as minors. In addition, a few fields in which no advanced degrees are offered have been approved as minors for candidates who are majoring in related areas. Such minor fields are identified by a brief statement under the field heading.

A candidate's choice of minor field depends upon the particular degree he is seeking and is subject to the approval of his major department. The requirements in each minor field are established by the minor department subject to the regulations of the Graduate Faculty.

**INTERDISCIPLINARY MAJORS**—In addition to the majors listed on page 50, interdisciplinary majors involving two or more departments may be arranged with the approval of the Dean of the Graduate School. These programs are offered under the supervision of appropriate interdepartmental committees.

**OTHER FIELDS**—Fields which have not been approved for either major or minor work at this institution, but in which approved courses are offered, are listed in Part II of this section. These courses may be used in graduate programs as electives or as part of a general studies program, subject to the approval of the major department and to the restrictions upon the use of 400 series courses in degree programs.

**COURSE NUMBERING SYSTEM**—Courses in the series 1-399 are not listed in this bulletin because they are strictly undergraduate courses and yield no graduate



credit. A graduate student may register for or audit these courses in order to make up deficiencies or fill in gaps in his earlier education but not to meet requirements for an advanced degree.

Courses in the series 400-499 are for upperclassmen with at least junior standing and for graduate students. Only a limited number of credits earned in these courses may be counted toward the requirements for an advanced degree. Detailed regulations are given in the preceding section of this bulletin.

Courses in the series 500-599 are restricted to students registered in the Graduate School and other students who, in exceptional cases, have been granted permission to enroll by the Dean of the Graduate School.

Course numbers 600 and 610 apply to research and thesis and are available only to students registered in the Graduate School.

**COURSE DESCRIPTIONS**—A course abbreviation, a number, and a title designate each course. Course designations and official abbreviations are listed at the left-hand margin just above the first course in each group. The figures in parentheses following the course title show the number of credits which may be granted for that course. In the case of courses with variable credits, the number of credits which may be earned in a single semester or session is determined by the department offering the course.

A department may schedule an entire section of a course below the 400 level for fewer credits than the maximum authorized. In 400 and 500 series courses a department may schedule an individual student for fewer credits than the maximum number but in no case for more than the maximum number authorized.

The letter "X" following a course number indicates that the course is approved for extension classes. The letter "v" following a course number indicates a vocational education course.

In many cases the name of the instructor who usually teaches the course is listed after the course description.

**SCHEDULE OF COURSES**—Not all courses are given each semester or session. A complete list of the courses which will be offered in any specific semester is given in the *Timetable*, which is available at nominal cost from the Registrar's Office a few weeks before the beginning of each semester. The *Timetable* gives the number of credits being offered in each course, the hours at which the class will meet, the location of the class, and in some cases the instructor's name.

The courses being offered during a specific summer session are given in the *Complete Announcement of the Summer Sessions* for that year. This announcement, which includes a timetable for summer sessions classes, may be obtained from the Summer Sessions office a few weeks before the beginning of the first session.

The list of courses given in the *Timetable* and the *Complete Announcement of the Summer Sessions* is subject to modification at registration time. The number enrolling in a course, the availability of staff members, and other circumstances may result in the cancellation of some courses and the offering of others. Decisions are made by the departments offering the courses.

**RESEARCH AND THESIS WORK**—In general, students registering for research or for work on a master's or a doctor's thesis will, if it is to be done in residence, use course number 600 preceded by the appropriate course abbreviation. Thus Aro.E. 600 signifies research or thesis in aeronautical engineering. In case such work has been authorized as off-campus work for nonresident students, the number 610 will be used. Credits will be 1 to 15 per semester.

## PROGRAMS AND COURSES

It should be assumed that the numbers 600 and 610 are available during the academic year in all fields in which majors have been approved for advanced degrees although these numbers do not appear in the timetables. In the summer, however, research and thesis work is usually available only in those fields for which 600 and 610 numbers appear in the *Complete Announcement* and the *Summer Sessions Timetable* for that year.

## FIELDS IN WHICH BOTH MASTERS' AND DOCTORS' DEGREES ARE OFFERED

Aeronautical Engineering	Geology
Agricultural and Biological Chemistry	Geophysics
Agricultural Economics	German
Agricultural Education	Higher Education (D.Ed. only)
Agronomy	History
Animal Husbandry	Home Economics Education
Animal Nutrition	Home Management and Family Economics
Art Education	Horticulture
Bacteriology	Industrial Arts Education
Biological Science	Mathematics
Botany	Mechanical Engineering
Business Administration	Metallurgy
Business Education	Meteorology
Ceramic Technology	Mineral Economics
Chemical Engineering	Mineral Preparation
Chemistry	Mineralogy and Petrology
*Child Development	Mining Engineering
Civil Engineering	Music Education
Clinical Speech	Nutrition
Clothing and Textiles	Petroleum and Natural Gas Engineering
Comparative Literature	Physical Education
Counseling in Education	Physics
Dairy Science	Plant Pathology
Economics	Political Science
Educational Administration	Poultry Husbandry
Electrical Engineering	Psychology
Elementary Education	Recreation Education
Engineering Mechanics	Romance Languages and Literatures
English	Rural Sociology
Entomology	Secondary Education
*Family Relationships	Sociology
Fuel Technology	Speech
General Home Economics	Vocational Industrial Education
Genetics and Breeding	Zoology
Geochemistry	
Geography	

## FIELDS IN WHICH ONLY A MASTER'S DEGREE IS OFFERED

Agricultural Engineering	Music
Architectural Engineering	Nuclear Engineering
Architecture	Nutrition in Public Health
Art	Philosophy
*Child Development and Family Relationships	Physical Science
Foods	Public Administration
Forestry	Sanitary Engineering
Industrial Engineering	Social Studies
Institution Administration	Theatre Arts
Journalism	Wildlife Management

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\* See page 75, Child Development and Family Relationships.



# *Part I*

## *Courses in Major and Minor Fields*

### AERONAUTICAL ENGINEERING

IRVING MICHELSON, *Head of the Department*  
203 Engineering D

The department offers graduate programs leading to the M.S. and Ph.D. degrees. Course work and research are available in aerodynamics, structures, aeroelasticity, turbomachinery, and dynamics.

A student should have a B.S. degree in engineering, mathematics, or physics to be admitted to graduate work in aeronautical engineering. He must have satisfactorily completed undergraduate courses in statics, dynamics, strength of materials, and mathematics at least through ordinary differential equations but preferably through vector analysis.

#### AERONAUTICAL ENGINEERING (ARO E)

##### 401a,b,c. AERONAUTICAL ENGINEERING PROJECTS (2-12)

##### 402. DESIGN AND TESTING OF AIRCRAFT ENGINE COMPONENTS (3)

##### 403. APPLIED AERODYNAMICS (3)

##### 404. AIRPLANE DESIGN AND TESTING (3)

##### 407. ROTARY WING AIRCRAFT (3)

##### 408. AIRCRAFT GAS TURBINES AND JET PROPULSION ENGINES (3)

##### 409. AIRCRAFT STRUCTURAL DETAIL DESIGN (3)

##### 410. AIRCRAFT PROPULSION (3)

##### 411. AEROELASTICITY (3)

##### 412. THEORETICAL AERODYNAMICS (3)

##### 413. AERONAUTICAL DYNAMICS (3)

##### 414. AIRCRAFT PRELIMINARY DESIGN (3)

##### 415. ADVANCED THEORETICAL AERODYNAMICS (3)

##### 416. MISSILE SYSTEMS LECTURES (0)

##### 417. MISSILE SYSTEMS LECTURES (0)

501. AIRPLANE STABILITY AND CONTROL (3) General analysis of longitudinal and lateral stability of airplanes; characteristics of flight control devices. Prerequisite: Aro.E. 403.

503. AIRPLANE PERFORMANCE (3) Methods of performance prediction and performance flight testing for high-speed aircraft and missiles. Prerequisite: Aro.E. 403.

504. ROTARY WING AIRCRAFT (3) Types of rotary wing aircraft; helicopter performance, stability, and control; structural and vibration problems. Prerequisites: Aro.E. 403, 409.

505. AEROELASTICITY (3) Vibrating systems with several degrees of freedom; analysis of flutter speed of an airplane wing considering bending, torsion, and aileron motions; other types of aircraft flutter. Prerequisites: Aro.E. 412; E.Mch. 401 or Aro.E. 411.

## AERONAUTICAL ENGINEERING

506. AIRCRAFT STRUCTURES (3-9) Deflections of beams and trusses; statically indeterminate structures; shear-flow analysis and shearing deformations of multicell semi-monocoque structures; effects of discontinuities in wing and fuselage structures. Prerequisites: Aro.E. 409, E.Mch. 408.
507. AIRCRAFT GAS TURBINES AND JET PROPULSION ENGINES (3) Types of jet propulsion installations, thermodynamic cycles, analysis of compressors, combustion chambers, and turbines. Prerequisite: Aro.E. 410.
510. AERODYNAMICS OF COMPRESSIBLE FLUIDS (3) One-dimensional motion, shock waves, flow in nozzles, two-dimensional flow, airfoil theory, Prandtl-Meyer flow, method of characteristics. Prerequisite: Aro.E. 412.
511. AERODYNAMICS OF A PERFECT FLUID (3) Euler's dynamic equations, complex potential, conformal transformation, thin airfoils, Biot-Savart law; Prandtl three-dimensional airfoil theory. Prerequisite: Aro.E. 412.
512. AERODYNAMICS OF A VISCOUS FLUID (3) Navier-Stokes equations, incompressible and compressible boundary layer theory, jet and wake problems, hydrodynamic stability, turbulence. Prerequisite: Aro.E. 412.
513. RESEARCH IN AERONAUTICAL ENGINEERING (1-15 per semester) Investigation of a theoretical or experimental project in aeronautical engineering.
514. AERONAUTICAL ENGINEERING SEMINAR (1 per semester) Current literature and special problems in aeronautical engineering.
515. AERODYNAMICS (3) Airflow, airplane performance. For students with undergraduate training in science or engineering curriculums other than aeronautical engineering.
516. SPECIAL TOPICS IN AIRCRAFT STRUCTURES (3-9)
519. FLUID DYNAMICS OF ROTATING MACHINERY (3-6) Prerequisite: Aro.E. 412.
520. SPECIAL TOPICS IN AERODYNAMICS (3-9)

## AGRICULTURAL AND BIOLOGICAL CHEMISTRY

HOWARD O. TRIEBOLD, *Head of the Department*  
109 Frear Laboratory

Graduate work leading to the M.S. and Ph.D. degrees is offered. An entering student should have had courses in mathematics, physics, biological sciences, inorganic chemistry, analytical chemistry, organic chemistry, and physical chemistry equivalent to those required of undergraduate students in the first three years of the agricultural and biological chemistry curriculum at this University. Students who lack some of the prerequisite courses may be admitted for graduate work but will be required to take the prerequisite courses without degree credit.

Opportunities for research and graduate study are available in plant metabolism and photosynthesis, intermediary metabolism, nucleic acids, proteins, carbohydrates, lipides, enzymes, vitamins, animal nutrition, poultry nutrition, clinical chemistry, endocrinology, and pesticides.

# AGRICULTURAL AND BIOLOGICAL CHEMISTRY

## AGRICULTURAL AND BIOLOGICAL CHEMISTRY (AB CH)

- |                                                                                                                                                                                                                                                                                                       |                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| 403. DAIRY CHEMISTRY (3)                                                                                                                                                                                                                                                                              | <i>Mr. Shigley</i>  |
| 404. FOOD CHEMISTRY (4)                                                                                                                                                                                                                                                                               | <i>Mr. Triebold</i> |
| 413. PRINCIPLES OF ANIMAL NUTRITION (3)                                                                                                                                                                                                                                                               | <i>Mr. Miller</i>   |
| 417. METHODS OF AGRICULTURAL ANALYSIS (4)                                                                                                                                                                                                                                                             | <i>Mr. Triebold</i> |
| 418. PLANT ANALYSIS (4)                                                                                                                                                                                                                                                                               | <i>Mr. Clagett</i>  |
| 421. CHEMISTRY OF MILLING AND BAKING (3)                                                                                                                                                                                                                                                              | <i>Mr. Triebold</i> |
| 425. BIOPHYSICAL CHEMISTRY (4)                                                                                                                                                                                                                                                                        | <i>Mr. Mallette</i> |
| 426. BIOCOLLOIDS (3)                                                                                                                                                                                                                                                                                  | <i>Mr. Mallette</i> |
| 427. POTENTIOMETRIC THEORY AND TECHNIQUE (3)                                                                                                                                                                                                                                                          |                     |
| 437. GENERAL BIOCHEMISTRY (5)                                                                                                                                                                                                                                                                         | <i>Mr. Pritham</i>  |
| 438. PHYSIOLOGICAL CHEMISTRY (CLINICAL METHODS) (5)                                                                                                                                                                                                                                                   | <i>Mr. Pritham</i>  |
| 439. PROBLEMS IN AGRICULTURAL CHEMISTRY (3-5)                                                                                                                                                                                                                                                         |                     |
| 440. PLANT BIOCHEMISTRY (3)                                                                                                                                                                                                                                                                           | <i>Mr. Clagett</i>  |
| 441. RADIOLOGICAL SAFETY (1)                                                                                                                                                                                                                                                                          |                     |
| 501. ENZYMES (2) Investigations and theories concerning nature of enzymes, enzyme action, influence of chemical environment on enzyme action, and biological applications. Prerequisite: A.B.Ch. 437. Offered each fall semester. <i>Mr. Clagett</i>                                                  |                     |
| 502. PHYSICAL CHEMISTRY OF THE CELL (3) Lectures and assigned reading reviewing current literature relative to physical chemistry of living tissues and life processes. Prerequisite: A.B.Ch. 426.                                                                                                    |                     |
| 503. BIOCHEMICAL PROBLEMS (1-10 per semester) Prosecution of an assigned problem under the guidance of an instructor. Offered each semester and summer session.                                                                                                                                       |                     |
| 505. VITAMINS AND DIETARY DEFICIENCY DISEASES (2) Lectures, conferences, and assigned reading. Prerequisite: A.B.Ch. 437. Offered in the fall semester of odd years. <i>Mr. Guerrant</i>                                                                                                              |                     |
| 506. VITAMIN ASSAY METHODS (2) Lectures, conferences, and demonstrations dealing with approved methods of vitamin assay and including demonstrations of typical vitamin deficiency syndromes in the rat. Prerequisite: A.B.Ch. 505. Offered in the spring semester of even years. <i>Mr. Guerrant</i> |                     |
| 507a. SEMINAR IN PHYSIOLOGICAL CHEMISTRY AND NUTRITION (1 per semester) Offered each semester. <i>Messrs. Guerrant, Boucher, Miller, and Pritham</i>                                                                                                                                                  |                     |
| 507b. SEMINAR IN FOODS AND ANALYTICAL CHEMISTRY (1 per semester) Offered each fall semester. <i>Messrs. Triebold, Althouse, and Shigley</i>                                                                                                                                                           |                     |
| 507c. SEMINAR IN PLANT, ENZYME, AND INSECTICIDE CHEMISTRY (1 per semester) Offered each spring semester. <i>Messrs. Frear, Benson, Mallette, and Clagett</i>                                                                                                                                          |                     |
| 508. BIOCHEMICAL LITERATURE (1-3) Assigned readings, reports, and conferences on selected topics in biochemistry. Prerequisite: A.B.Ch. 437. Offered each semester.                                                                                                                                   |                     |
| 509. BIOCHEMICAL METHODS (3) Lectures and advanced laboratory on current techniques used in biochemical research. Prerequisites: Phys. 285, Chem. 461. Offered each spring semester. <i>Messrs. Benson and Mallette</i>                                                                               |                     |
| 510. PROTEINS, AMINO ACIDS, AND PEPTIDES (2) Organic, physical, and biological chemistry of the naturally occurring compounds of this group. Prerequisites: A.B.Ch. 425, 437. Offered each fall semester. <i>Mr. Mallette</i>                                                                         |                     |



## AGRICULTURAL AND BIOLOGICAL CHEMISTRY

511. CARBOHYDRATES (2) Chemical constitution and properties of carbohydrates; their metabolism in plant and animal organisms. Prerequisite: A.B.Ch. 437. Offered each spring semester. *Mr. Benson*
512. LIPIDES (2) Investigations on biochemistry of fats and related substances. Offered each spring semester. *Mr. Althouse*
513. PHYSICOCHEMICAL MEASUREMENTS USED IN BIOLOGICAL RESEARCH (4) Laboratory course, quantitative in nature, valuable as preparation for A.B.Ch. 502. Hydrogen-ion concentration, electrometric titration, buffers, oxidation-reduction potential, and membrane potential. Prerequisite: A.B.Ch. 425 or Chem. 463.
515. BIOMETRY (2) Application of statistical methods to research problems in biochemistry and biology. Prerequisite: Ag. 400. Offered in the spring semester of odd years. *Mr. Miller*
516. CHEMISTRY OF THE PESTICIDES (2) Lectures and assigned readings on the chemistry of insecticides, fungicides, herbicides, rodenticides, and related materials. Prerequisite: Chem. 31 or A.B.Ch. 437. Offered in the fall semester of even years. *Mr. Frear*
517. ENDOCRINE SECRETIONS (2) Chemistry of hormones and their physiological significance. Prerequisite: A.B.Ch. 437. Offered in the spring semester of even years. *Mr. Pritham*
518. MINERAL METABOLISM (2) Utilization and function of mineral elements in animal nutrition. Prerequisite: A.B.Ch. 437. Offered in the spring semester of odd years. *Mr. Boucher*

## AGRICULTURAL ECONOMICS

MACKLIN E. JOHN

*Head of the Department of Agricultural Economics and Rural Sociology*  
1 Weaver Building

A graduate program leading to the M.S. or Ph.D. degree may be taken in agricultural economics. The entering student in the master's program should have as prerequisites 3 credits in agricultural economics, 3 credits in economics, and 3 additional credits in either agricultural economics or economics. If the entering student does not have the prerequisites, they may be taken at this University during the early part of his master's program.

### AGRICULTURAL ECONOMICS (AG EC)

- 400, 400X. PUBLIC POLICIES IN AGRICULTURE (1-2)
407. ADVANCED FARM MANAGEMENT (3)
420. AGRICULTURAL PRICES (3) *Mr. Brandow*
421. LAND ECONOMICS (3) *Mr. Frey*
426. (A.H. 426). LIVESTOCK MARKETING (3) *Mr. Trotter*
440. ECONOMICS OF AGRICULTURAL PRODUCTION (3)
500. SEMINAR IN AGRICULTURAL ECONOMICS (1-6) Review of current literature and problems.

## AGRICULTURAL ECONOMICS

503. RESEARCH METHODS IN FARM MANAGEMENT (1-3) Evaluation of research procedures, methods, results, and needs in the field; emphasis on their application to specific research problems. Prerequisites: Ag.Ec. 6, Econ. 14.
504. AGRICULTURAL PRICE AND INCOME POLICY (3) Analysis of farm prices, income consequences for producers and consumers, and effects on resource use; evaluation of policy, considerations in policy making. Prerequisites: Ag.Ec. 420, Econ. 405.  
*Mr. Brandow*
505. ADVANCED AGRICULTURAL STATISTICS (3) Multiple correlation, curve fitting, analysis of variance, selection of samples, and other techniques applicable to the rural social sciences. Prerequisite: 3 credits in statistics.  
*Mr. Bennett*
506. ECONOMIC PROBLEMS IN MARKETING SPECIFIC AGRICULTURAL PRODUCTS (1-4)
507. SEMINAR IN FARM MANAGEMENT (1-6) Special problems relating to organization and operation of the farm business. Prerequisites: Ag.Ec. 6, Econ. 14.
508. CURRENT LITERATURE SEMINAR IN ECONOMICS OF AGRICULTURAL MARKETING (1-3)
510. ADVANCED FARM FINANCE (1-3) Problems and policies in agricultural credit, insurance, and farm financial management.
515. ECONOMIC PROBLEMS IN THE MARKETING OF DAIRY PRODUCTS (3) Economic problems as they are encountered in the process of marketing; particular attention to governmental regulation in pricing and marketing.  
*Mr. Pierce*
517. PROBLEMS AND POLICIES OF FARMER CO-OPERATIVES (3) Specific types of co-operative organizations, their problems, policies, and progress; relationships existing among co-operatives, between co-operatives and other business organizations, and between co-operatives and the public. Prerequisite: Ag.Ec. 17.  
*Mr. Becker*
520. FARM PRICE ANALYSIS (3) Econometric analysis of prices, production, and utilization of farm products; review of research in this field. Prerequisites: Ag.Ec. 420, 505; Econ. 405.  
*Mr. Brandow*
522. ADVANCED FARM APPRAISAL (3) Land value theory; methods of land valuation; field practice in farm appraisal.  
*Mr. Frey*
525. RESEARCH METHODS IN RURAL SOCIAL SCIENCES (2) Scientific method in planning and conducting research. Prerequisite: 9 credits in social sciences. *Mr. John*
526. RESEARCH METHODS IN AGRICULTURAL ECONOMICS (2) Application of economic and statistical principles.  
*Mr. Baker*

## AGRICULTURAL EDUCATION

HENRY S. BRUNNER, *Head of the Department*  
101 Agricultural Education Building

Graduate programs are offered which lead to the M.Ed., M.S., D.Ed., and Ph.D. degrees. Minors may be taken in any of the areas of agricultural technology, or, for Master of Science and Doctor of Philosophy degree candidates, in one of the other fields of education, such as educational administration or higher education.

## AGRICULTURAL EDUCATION

The requirements for admission are 21 semester hours in professional education courses including educational psychology and practice teaching in vocational agriculture, or certification to teach vocational agriculture. Students who lack any part of these requirements may be admitted but are required to fulfill deficiencies without degree credit.

### AGRICULTURAL EDUCATION (AG ED)

- 416v. RURAL EDUCATION (3)  
417v, 417vX. RURAL EDUCATION SURVEY (2) *Mr. Brunner*  
418v, 418vX. SURVEY OF VOCATIONAL EDUCATION IN AGRICULTURE (1-3) *Mr. Brunner*  
420v, 420vX. ADVANCED VISUAL AND OTHER SENSORY AIDS IN TEACHING AGRICULTURE (1-6) *Mr. Anthony*  
422v, 422vX. SUPERVISION OF VOCATIONAL EDUCATION IN AGRICULTURE (1-3) *Mr. Anthony*  
434v, 434vX. AGRICULTURAL DEVELOPMENTS (1-6) *Mr. Brunner*
- 501v. HISTORY OF AGRICULTURAL EDUCATION (1-3) Development of training for agricultural vocations; emphasis upon introduction of agricultural instruction into the high school program. *Mr. Brunner and Staff*
- 502v, 502vX. TEACHING VOCATIONAL AGRICULTURE (1-3) Organization of instruction with respect to vocational objectives, methods of presentation, supervision of practice, pupil evaluation of goals, and follow-up. *Mr. Brunner*
- 503v, 503vX. RESEARCH IN AGRICULTURAL EDUCATION (1-6 per semester) Individual study problems in various phases of agricultural education, such as evaluation of teaching, teaching procedures, and teacher preparation. *Mr. Brunner and Staff*
- 504v. AGRICULTURAL EDUCATION SEMINAR (1 per semester) *Mr. Brunner and Staff*
- 506v, 506vX. PROBLEMS IN COUNTY VOCATIONAL SUPERVISION (1-3) Needs of county supervisors and vocational directors; co-operation with county superintendents, supervisory duties, plans of work, community meetings and organizations.
- 508v. STATE AND COUNTY ADMINISTRATION AND SUPERVISION OF AGRICULTURAL EDUCATION (1-3) Organization and administration of state, county, township, and district systems of agricultural education; state and federal legislation.
- 509v, 509vX. TEACHER TRAINING IN AGRICULTURAL EDUCATION (1-6) Construction of college curriculums, courses of study, and organization of college departments for training agricultural teachers. *Mr. Brunner*
- 520v, 520vX. SCIENTIFIC METHOD IN THE STUDY OF AGRICULTURAL EDUCATION (1-4) Methods of procedure in investigation and experimentation in education, accompanied by a critical examination of studies made in agricultural education. *Mr. Stevens*
- 521v, 521vX. SCIENTIFIC METHOD IN THE STUDY OF AGRICULTURAL EDUCATION (1-4) Continuation of Ag.Ed. 520v; emphasis upon statistical techniques for students' individual problems. *Mr. Stevens*
- 522v, 522vX. FIELD STUDIES IN AGRICULTURAL EDUCATION (1-4) Organization and administration of agricultural education in its local bearings; field laboratory surveys of local school conditions. *Mr. Brunner and Staff*



523v, 523vX. FIELD STUDIES IN AGRICULTURAL EDUCATION (1-4) *Mr. Brunner and Staff*

524v, 524vX. ANNUAL PLAN OF WORK (1-3) Detailed study of the agricultural education needs of each student's community and outlining annual plans of work.  
*Mr. Brunner*

530v. AGRICULTURAL COLLEGE TEACHING (3) Selection and organization of subject matter for specific courses, methods of learning, teaching devices, technique of teaching, and measurements of results of teaching.  
*Mr. Brunner*

## AGRICULTURAL ENGINEERING

FRANK W. PEIKERT, *Head of the Department*  
202 Agricultural Engineering Building

The department offers major work for the M.S. degree with specialization in farm power and machinery, rural electrification, soil and water conservation engineering, and farm structures.

Prerequisite to major work is the completion of an undergraduate curriculum substantially equivalent to that required for the B.S. degree in agricultural engineering at this University.

### AGRICULTURAL ENGINEERING (AG E)

400. AGRICULTURAL ENGINEERING PROBLEMS (1-7)

401. FARM MECHANICS FOR TEACHERS OF VOCATIONAL AGRICULTURE (1½-9)

*Unit A. Farm Utilities (1½)*

*Unit B. Farm Mechanics (1½)*

*Unit C. Farm Engines (1½)*

*Unit D. Farm Machinery (1½)*

*Unit E. Farm Buildings (1½)*

*Unit F. Soil and Water Structures (1½)*

402. FUNCTIONAL DESIGN OF FARM STRUCTURES (3)

405. ADVANCED FARM ELECTRIFICATION (3)

406. ADVANCED DAIRY ENGINEERING (3)

500. ADVANCED ELECTRO-AGRICULTURE (1-6) Investigations in the application of electrical energy to processing, storing, and handling agricultural products. Seminar, written reports.

501. ADVANCED FARM MACHINERY (1-6) Application of agricultural engineering principles to design and operation of farm machinery. Prerequisite: Ag.E. 110.

502. FARM STRUCTURES PROBLEMS (1-6) Analysis of farm structures design problems.

507. PROBLEMS IN SOIL WATER ENGINEERING (1-6) Analysis of engineering problems relating to irrigation, drainage, or erosion control.

508. ADVANCED PROBLEMS IN FARM MECHANICS (1-15) Problems in farm shop practice and agricultural engineering related to the farm mechanics program of vocational education in agriculture. Prerequisites: Ag.E. 8, 14; or teaching experience in farm mechanics.

## AGRICULTURAL ENGINEERING

509. RESEARCH IN AGRICULTURAL ENGINEERING (1-4)

520. AGRICULTURAL ENGINEERING SEMINAR (1-3) Reports on research and special topics.

## AGRONOMY

HOWARD B. SPRAGUE, *Head of the Department*  
118 Tyson Building

Graduate work leading to the M.S. and Ph.D. degrees is offered. Areas of specialization for each degree include soil chemistry; soil conservation; soil classification; soil fertility; soil mineralogy; soil physics; the breeding of corn, small grains, and forage plants; forage management; turf management; potato culture; tobacco culture; weed control; and ecology of crops and pastures. Facilities are available for X-ray diffraction, infrared, and petrographic investigations of soils.

Prerequisites for major work in agronomy vary with the area of specialization, but basic courses in chemistry, mathematics, physics, and biological sciences are required. Students who lack some of the course prerequisites may be admitted but are required to take the prerequisite courses without degree credit.

### AGRONOMY (AGRO)

- |                                              |                                     |
|----------------------------------------------|-------------------------------------|
| 411. BREEDING OF FIELD CROPS (3)             | <i>Mr. Cleveland</i>                |
| 416. SOIL CLASSIFICATION (5)                 | <i>Mr. Higbee</i>                   |
| 419. SOIL PROPERTIES (5)                     | <i>Mr. Satchell</i>                 |
| 422. SOIL CONSERVATION (3)                   | <i>Mr. Kardos</i>                   |
| 423. PASTURE AND GRASSLAND MANAGEMENT (3)    | <i>Mr. Washko</i>                   |
| 424. FERTILIZER TECHNOLOGY (3)               | <i>Mr. Marriott</i>                 |
| 429. (Bot. 429). WHITE POTATO PRODUCTION (3) | <i>Messrs. Harrington and Mills</i> |
| 490. AGRONOMIC PRACTICES (1-6)               | <i>Mr. Washko and Staff</i>         |
501. ADVANCED SOIL FERTILITY (4) Interpretation of fertility experiments and diagnosis of soil-plant relationships through field appraisal, analysis, and plant symptoms. Prerequisites: Agro. 31, Bot. 406. Offered in the spring semester of odd years.  
*Mr. Hunter*
503. AGRONOMY SEMINAR (1) Weekly meeting where papers and discussions will be presented by students and staff members. Offered each semester. *Mr. H. B. Sprague*
506. SOIL CHEMISTRY (4) Analyses of important chemical and biochemical reactions occurring in soils, conditions which control these reactions and their importance in soil genesis and plant growth; laboratory work in the more typical and significant analytical procedures; lectures, review of current literature, and practicum. Prerequisites: Agro. 419; A.B.Ch. 417 or Chem. 20. Offered in the spring semester of even years.  
*Mr. Satchell*
507. SOIL PHYSICS (4) Physical properties of the soil; factors affecting them; their measurements, evaluation, and influence in determination of soil productivity. Prerequisites: Agro. 419, Phys. 215, A.B.Ch. 425. Offered in the fall semester of even years.  
*Mr. Kardos*
509. GENETICS OF CROP PLANTS (3) Inheritance in crop plants with particular reference to factor interaction, genetic aspects of linkage and crossing-over, quanti-

- tative inheritance, and heterosis. Prerequisite: Bot. 422. Offered in the fall semester of even years. *Mr. Cleveland*
510. THE APPLICATION OF CYTOGENETICS TO PLANT BREEDING (3) Cytogenetics, including chromosome structure and behavior, chromosome alterations, polyploidy, interspecific hybridization and their applications to plant breeding. Prerequisite: Bot. 422. Offered in the fall semester of odd years. *Mr. Cleveland*
512. FIELD PLOT TECHNIQUE (4) Ramifications of analysis of variance techniques; combining and analyzing data from several experiments; selection of valid error terms. Prerequisite: Math. 8 or Ag. 400. Offered each fall semester. *Mr. Fortmann*
516. HUMUS (2) Origin and chemical nature of soil organic matter, its importance in soil processes, and its decomposition. Prerequisites: Agro. 31, 419. Offered in the fall semester of odd years. *Mr. Richer*
517. FARM CROPS ECOLOGY (2) Ecological factors influencing distribution and production of field crops. Prerequisites: Math. 8, Bot. 406. Offered in the fall semester of even years. *Mr. Huber*
518. GROWTH AND MANAGEMENT OF FORAGE CROPS (3) Factors affecting growth and development of forage crops with particular reference to effects of environment, defoliation, and management practices. Prerequisites: Agro. 423, Bot. 406. Offered in the spring semester of odd years.
519. THE NATURE OF SOIL MINERALS (3) Modern methods for identification of the constituent minerals of soils and their relation to soil classification and agricultural practices. Prerequisites: Agro. 1, Chem. 2, Geol. 31. Offered in the spring semester of even years. *Mr. Jeffries*
520. SPECIAL SOILS PROBLEMS (1-6 per semester) Provides basic or practical training in the soils sciences by means of library, field, and laboratory assignments. Offered each semester.
545. THE APPLICATION OF STATISTICS TO FIELD EXPERIMENTS (4) Use of advanced experimental designs in planning, analyzing, and interpreting experiments; includes lattice designs, factorials, confounding, simple and multiple covariance techniques. Prerequisite: Agro. 512. Offered each spring semester. *Mr. Fortmann*
550. SPECIAL CROPS PROBLEMS (1-6 per semester) Provides basic or practical training in the crops sciences by means of library, field, and laboratory assignments. Offered each semester.
582. SEMINAR IN THE BREEDING AND GENETICS OF FARM CROPS (1-8 per semester) Offered each semester.
583. LABORATORY METHODS IN AGRONOMIC RESEARCH (3) Prerequisite: Agro. 512. Offered each summer.

## ANIMAL HUSBANDRY

GLENN R. KEAN, *Acting Head of the Department*  
203 Armsby Building

The department offers major work for the M.S. and Ph.D. degrees with specialization in animal production, animal breeding, and meats.



## ANIMAL HUSBANDRY

The prerequisite to major graduate work in animal husbandry is the completion of an undergraduate curriculum substantially equivalent to that recommended for undergraduate training in the animal husbandry curriculum at this University.

### ANIMAL HUSBANDRY (A H)

- 421. ADVANCED MEAT STUDIES (3)
- 423. ADVANCED STOCK JUDGING (2)
- 424. ANIMAL HUSBANDRY SEMINAR (1)
- 426. (Ag.Ec. 426). LIVESTOCK MARKETING (3)
- 431. ADVANCED MEAT JUDGING (2)
  
- 500. SEMINAR IN ANIMAL HUSBANDRY (1-6)
- 501. PEDIGREE STUDY (1-6) Research work in breed study history, and analytical study of breed pedigrees, and a complete survey of the herd, flock, or stud book.
- 502. RESEARCH IN MEATS (1-6 per semester) Investigation of methods for handling, cutting, processing, freezing, and curing meat and meat products. Prerequisite: A.H. 421.
- 503. LIVESTOCK MANAGEMENT (3) Handling of purebred herds and flocks; relation of livestock breeders to the public and methods of developing purebred herds and flocks through careful breeding.
- 505. ADVANCED ANIMAL BREEDING (1-5) Special problems in animal genetics as applied to breeding and improvement of horses, cattle, sheep, and swine. Prerequisites: A.H. 22, Bot. 22.

## ANIMAL NUTRITION

RAYMOND W. SWIFT, *Head of the Department*  
21 Armsby Building

The M.S. and Ph.D. degrees are offered with a major in animal nutrition. For admission a student must have had A.Ntr. 401 and 402 or their equivalent and must have met the requirements for graduate work in agricultural and biological chemistry. Specialized training is offered in the area of energy metabolism. Candidates select courses for this major from a number of related fields.

### ANIMAL NUTRITION (A NTR)

- 401. PHYSIOLOGY OF NUTRITION (3)
- 402. PHYSIOLOGY OF NUTRITION (3)

*Mr. Barron*  
*Mr. French*

## ANTHROPOLOGY

WILLIAM G. MATHER, *Head of the Department of Sociology*  
203 Sparks Building

No advanced degree is offered in this field, but a candidate with a major in another field may choose a minor in anthropology with the approval of his major department.

ANTHROPOLOGY (ANTHY)

443. ANTHROPOLOGY OF THE OLD WORLD (3) *Mr. Mook*  
 445. PRIMITIVE SOCIETY (3) *Mr. Mook*
540. THEORY AND METHOD IN ANTHROPOLOGY (3) Theory and method used in culture-historical, sociological, and psychological interpretations. *Mr. Mook*
545. SEMINAR IN ANTHROPOLOGY (1-9) Critical analysis of research in selected areas of regional ethnography and ethnological theory. Prerequisites: Anthy. 45, 445. *Mr. Mook*

ARCHITECTURE

MILTON S. OSBORNE, *Head of the Department*  
 302 Sackett Building

The department offers graduate work leading to the M.S. degree with a major in architecture. To enter this field, a degree of Bachelor of Architecture, Bachelor of Science in Architecture, or Bachelor of Fine Arts in a five-year curriculum in architecture is required.

Graduate work may also lead to the M.S. degree with a major in architectural engineering. To enter this field, a degree of Bachelor of Architectural Engineering or Bachelor of Science in Architectural Engineering is required.

The entering student should have had the courses, or equivalents, required by this University for the baccalaureate degree in the field designated for graduate study.

ARCHITECTURE (ARCH)

410. ADVANCED ARCHITECTURAL DESIGN (2-12) *Mr. Osborne and Staff*  
 411. ADVANCED ARCHITECTURAL DESIGN (8)  
 412. ADVANCED ARCHITECTURAL DESIGN AND THESIS (8)  
 421. (A.A.H. 421). CONTEMPORARY ARCHITECTURE (3)
501. ARCHITECTURAL DESIGN (4-8) Problems in advanced planning and design, including study of group composition. Practicum and seminar. *Mr. Osborne and Staff*
502. ARCHITECTURAL RESEARCH (2-12) Prosecution of assigned problems under the guidance of an instructor. *Mr. Osborne and Staff*
503. ARCHITECTURAL HISTORY RESEARCH (3-12) Original research in architectural history. Seminar and written reports. *Mr. Dickson and Staff*

ARCHITECTURAL ENGINEERING (A E)

401. ARCHITECTURAL ENGINEERING (3)  
 402. ARCHITECTURAL ENGINEERING (4)  
 403. ARCHITECTURAL ENGINEERING (3)  
 420. ARCHITECTURAL ENGINEERING (3)  
 421. ARCHITECTURAL ENGINEERING (4)

## ARCHITECTURE

- 422. ARCHITECTURAL ENGINEERING (3)
- 423. ARCHITECTURAL ENGINEERING THESIS (2)
- 424. ARCHITECTURAL ENGINEERING THESIS (5)

502. ARCHITECTURAL ENGINEERING (3-8) Advanced structural design in steel and reinforced concrete. Lectures and class criticism. Practicum and seminar.

*Mr. Richardson and Staff*

503. ARCHITECTURAL ENGINEERING (4-8) Continuation of A.E. 502 in which problems of wind bracing in tall buildings, rigid frames, and heavy-framed constructions are studied. Practicum and seminar.

*Mr. Richardson and Staff*

504. ARCHITECTURAL ENGINEERING (4-8) Statically indeterminate stresses in steel and reinforced concrete buildings; area moment, slope deflection, and moment distribution methods. Recitation and seminar.

*Mr. Richardson and Staff*

## ART

ALBERT CHRIST-JANER, *Acting Head of the Department*  
209 Sparks Building

Graduate work leading to the M.A. degree is offered in this field. Students may specialize in studio work or the history of art and architecture, or may combine the two areas to satisfy the major requirements.

For admission at least 18 credits of undergraduate work in art are required. The graduate program is contingent upon the student's undergraduate preparation. If an inadequacy exists, the student will be required to make up the deficiency without degree credit.

### ART (ART)

- 400. OIL PAINTING: LANDSCAPE, STILL LIFE, AND FIGURE (3-12)
- 410. WATER-COLOR PAINTING: LANDSCAPE, STILL LIFE, AND FIGURE (3-9)
- 420. APPLIED DESIGN (3-9)
- 490. LIFE DRAWING (3)

500. ART RESEARCH (2-6) Prosecution of assigned problems under the guidance of an instructor.

### ART AND ARCHITECTURAL HISTORY (A A H)

- 421. (Arch. 421). CONTEMPORARY ARCHITECTURE (3)
- 448. HISTORY OF PRINTS AND DRAWINGS (3)

501. ITALIAN PAINTING (2-6) Investigations of early Italian painting. Seminar, written reports.

*Mr. Dickson*

502. MEDIEVAL SCULPTURE (2-6) Sculpture of Italy and France from the 9th to the 13th centuries. Seminar, written reports.

*Mr. Norton*



503. ART HISTORY RESEARCH (3-12) Original investigation in art history, to be pursued independently or concurrently with course work in particular fields. Prerequisite: 6 credits in history of art.

504. SEMINAR: ART LITERATURE AND ICONOGRAPHY (2-6) Methods of research in the fine arts; survey of the literature of art; studies in iconography. Prerequisite: 6 credits in history of art.

#### ART—MUSIC—THEATRE (A M T)

400. CONTEMPORARY FORMS IN ART, MUSIC, THEATRE I (3)

401. CONTEMPORARY FORMS IN ART, MUSIC, THEATRE II (3)

## ART EDUCATION

VIKTOR LOWENFELD, *Head of the Department*  
207B Burrowes Building

Advanced work leading to the M.Ed., M.S., D.Ed., and Ph.D. degrees is offered. It is generally expected that students admitted to work toward a master's degree have one year of teaching experience and present the equivalent of an approved four-year art education curriculum. A student may not receive his doctor's degree without having had at least two years of successful teaching experience.

#### ART EDUCATION (A ED)

402. PROFESSIONAL ORIENTATION OF THE ART TEACHER (3) *Mr. Mattil*

404. METHODS OF GRAPHICS AND ILLUSTRATIONS (3)

414, 414X. ADVANCED CRAFTS FOR TEACHERS (3-6) *Mr. Beittel*

420. CERAMICS FOR TEACHERS (3)

434, 434X. ART APPRECIATION IN THE EDUCATIONAL PROGRAM (3) *Mr. Beittel*

434b, 434bX. ART IN THE ELEMENTARY SCHOOL (2-3) *Mr. Lowenfeld*

434c, 434cX. ART IN THE SECONDARY SCHOOL (3) *Mr. Mattil*

434d. ART SUPERVISION (3) *Mr. Mattil*

486, 486X. CURRENT PROBLEMS IN ART EDUCATION (2-3) *Mr. Mattil*

487. MURAL PAINTING IN SCHOOLS (3) *Mr. Lowenfeld*

488. ADVANCED MURAL PAINTING IN SCHOOLS (3) *Mr. Lowenfeld*

489. ART EXPERIENCES WITH CHILDREN (3)

504. ADVANCED METHODS IN GRAPHIC PROCESSES (3) Exploration through laboratory experience of printing method; etching, silk screen, linoleum, or other. Applications in teaching.

514. FUNCTIONAL RELATIONSHIPS IN CRAFTS (3) Relationships of material design and purpose in crafts discussed by means of outstanding products of different materials, periods, and cultures. Prerequisite: 6 credits in crafts or 3 in design and 3 in advanced crafts.

516. ANALYSIS OF THREE-DIMENSIONAL PROCESSES IN ART (3) Three-dimensional processes analyzed with regard to kinetic, textural, form, and other functions.

## ART EDUCATION

534. CREATIVE ART ACTIVITY FOR THE HANDICAPPED (3) Specific methods for development of creative art activity with the physically, mentally, emotionally, and socially handicapped; adjustive effect upon them. Prerequisite: 6 credits in art education or 6 in special education or 6 in psychology. *Mr. Lowenfeld*
586. RESEARCH IN ART EDUCATION (3-9) Current experiments in art education; required of students working for a master's degree in art education. *Mr. Beittel*
588. HISTORY OF ART EDUCATION (3) Historical development of philosophies in art education in the United States and abroad. *Mr. Lowenfeld*

## BACTERIOLOGY

ROBERT W. STONE, *Head of the Department*  
204 Patterson Building

Graduate work leading to the M.S. and Ph.D. degrees is offered. Specialized areas of study include bacterial physiology, soil microbiology, food and industrial microbiology, immunology, and virology. There is opportunity for research in animal disease in co-operation with the Department of Veterinary Science.

Prerequisites for graduate work are 20 semester hours of chemistry including quantitative analysis and organic chemistry, and 20 semester hours of biological science including 8 hours of microbiology. It is possible to substitute additional chemistry credits for part of the biology requirement.

### BACTERIOLOGY (BACT)

401. GENERAL MICROBIOLOGY (4)
407. BACTERIOLOGY PROBLEMS (2-9)
410. IMMUNOLOGY AND SEROLOGY (4)
411. BACTERIOLOGICAL SURVEY (1)
412. ADVANCED BACTERIOLOGY (4)
413. SOIL MICROBIOLOGY (3)
414. FOOD MICROBIOLOGY (4)
416. INDUSTRIAL MICROBIOLOGY (4)
506. RESEARCH (1-15 per semester) Special problems in microbiology.
507. SEMINAR (1 per semester) Reports on current fields of research.
508. PHYSIOLOGY OF BACTERIA (2) Composition, nutrition, and growth of microorganisms; influence of physical and chemical environment on metabolism.
- 508a. LABORATORY IN PHYSIOLOGY OF BACTERIA (2) Laboratory work to accompany the lectures given in Bact. 508.
509. FERMENTATION (2) Chemical activities of microorganisms; mechanisms of fermentative and oxidative metabolism.
510. LABORATORY IN FERMENTATION (2) Laboratory procedures and problems in fermentation to accompany Bact. 509.

512. BACTERIOLOGICAL TECHNIQUES (1-6) Practice in special laboratory techniques including manometry, tissue culture, and serology.
515. (V.Sc. 515). VIROLOGY (2-4) Rickettsial and viral agents parasitizing man, animals, and microorganisms. Prerequisite: Bact. 410.
516. BACTERIAL GENETICS (2-4) Mechanisms of variation in microorganisms including mutation, adaptation, sexual recombination, transduction, and transforming factors. Prerequisite: 3 credits each in bacteriology and genetics.

## BIOLOGICAL SCIENCE

HENRY W. POPP, *Chairman of the Committee on Biological Science*  
206 Buckhout Laboratory

The M.Ed. and D.Ed. degrees are offered with a major in biological science. The program is designed to meet the needs of secondary school science teachers.

The candidate for the M.Ed. degree must take at least 24 credits chosen from bacteriology, botany, and zoology and entomology, as well as at least 6 credits in basic education. He is expected to complete at least one course in each of the basic sciences.

In order to enter a program for a higher degree with a major in biological science, the candidate should present 24 credits in the biological sciences and 27 credits in education, including educational psychology and practice teaching. As many as 6 credits may be made up as undergraduate deficiencies after the candidate is admitted to the Graduate School.

The M.S. degree is offered in agricultural and biological chemistry, bacteriology, botany, entomology, genetics and breeding, plant pathology, and zoology, but not in the broad field of biological science.

## BOTANY

HENRY W. POPP  
*Head of the Department of Botany and Plant Pathology*  
206 Buckhout Laboratory

The M.S. and Ph.D. degrees are offered in the field of botany. The student majoring in botany may specialize in any one of the branches of this subject, such as plant anatomy, cytology, ecology, genetics, morphology, mycology, physiology, and taxonomy. In order to enter graduate work in this field, a student should present 27 credits of undergraduate work in botany or 21 credits in botany and 6 in biological science. As many as 6 credits may be made up as undergraduate deficiencies after the candidate has been admitted to the Graduate School.

In addition to its excellent facilities for research in various phases of botany, genetics, and plant pathology, the department is now equipped with a Gamma Radiation Laboratory for the study of irradiation effects upon plants, and other facets of radiation biology.

See also "*Plant Pathology*" and "*Genetics and Breeding*."



## BOTANY

### BOTANY (BOT)

- |                                                                      |                                    |
|----------------------------------------------------------------------|------------------------------------|
| 405. (Zool. 405). GENERAL CYTOLOGY (3)                               | Mr. Grun                           |
| 406. PLANT PHYSIOLOGY (4)                                            | Mr. Fritz                          |
| 407. PLANT ANATOMY (3)                                               | Mr. Kribs                          |
| 408. PLANT PATHOLOGICAL TECHNIQUES (3)                               | Mr. Bloom                          |
| 409. PLANT ECOLOGY (3)                                               | Mr. Kovar                          |
| 412. ADVANCED FOREST PATHOLOGY (3)                                   | Mr. Fergus                         |
| 414, 414X. TAXONOMY OF VASCULAR PLANTS (3)                           | Mr. Wahl                           |
| 415. MORPHOLOGY OF THE ALGAE (3)                                     | Mr. Wahl                           |
| 416. MORPHOLOGY OF THE BRYOPHYTES (2)                                | Mr. Grove                          |
| 417. MORPHOLOGY OF THE TRACHEOPHYTA EXCLUSIVE OF ANGIOSPERMS (3)     | Mr. Grove                          |
| 418. BOTANICAL PROBLEMS (1-6)                                        | Mr. Popp and Staff                 |
| 419. MYCOLOGY (3)                                                    | Mr. Fergus                         |
| 420. MORPHOLOGY OF THE ANGIOSPERMS (3)                               | Mr. Grove                          |
| 421. BOTANICAL TECHNIQUE (3)                                         | Mr. Grove                          |
| 422. (Zool. 422). ADVANCED GENETICS (3)                              | Messrs. Wright, Grun, and Mitchell |
| 424. COMMERCIAL TROPICAL WOODS (3)                                   | Mr. Kribs                          |
| 427. ADVANCED SYSTEMATIC BOTANY (1-6)                                | Mr. Wahl                           |
| 428. ADVANCED PLANT PATHOLOGY (2)                                    | Mr. Bloom                          |
| 429. (Agro. 429). WHITE POTATO PRODUCTION (3)                        | Mr. Mills                          |
| 433. (Zool. 433). GENETICS, EUGENICS, AND EVOLUTION FOR TEACHERS (3) | Messrs. Wright, Grun, and Mitchell |
500. PLANT PHYSIOLOGY SEMINAR (1 per semester) Selected topics from recent literature; staff and student reports on current research. Offered in the spring semester of even years. *Messrs. Popp and Fritz*
501. THE PHYSIOLOGY OF THE FUNGI (3) Chemical composition, metabolism, toxic and stimulating agencies, spore germination, growth and irritability of the fungi. Prerequisites: Bot. 406, 419, and preferably Chem. 32. Offered in the fall semester of even years. *Mr. Fergus*
505. (Zool. 505). CYTOLOGY AND CYTOGENETICS (3) Chromosome mechanism of heredity; relationship between plant and animal evolution and breeding and changes in chromosomes; cytological and cytochemical techniques. Prerequisite: Bot. or Zool. 22. Offered in the fall semester of even years. *Mr. Grun*
506. COMPARATIVE ANATOMY OF VASCULAR PLANTS (3) Structure of the Tracheophyta from a phylogenetic standpoint. Prerequisite: Bot. 407. Offered in the spring semester of even years. *Mr. Kribs*
509. PHYSIOLOGY OF PATHOGENICITY (3) Physiological processes of plant pathogenic bacteria and fungi occurring during incubation, ingress, and infection. Prerequisite: Bot. 10, 11, or 419. Offered in the fall semester of even years. *Mr. Schein*
- \* 511. PHYSIOLOGY OF PLANT GROWTH AND DEVELOPMENT (2-4) Prerequisite: Bot. 406. Offered in the spring semester every 2 or 3 years. *Mr. Popp*
- \* 512. PHYSIOLOGY OF PLANT METABOLISM (2-4) Prerequisite: Bot. 406. Offered in the fall semester of even years. *Mr. Fritz*
- \* 513. WATER AND MINERAL RELATIONS OF PLANTS (2-4) Absorption of water and minerals; transport of materials within the plant; physiology of transpiration. Prerequisite: Bot. 406. Offered in the fall semester of odd years. *Mr. Fritz*

\* Credits to be arranged, 2 or 4.

515. DISEASE RESISTANCE IN PLANTS (2-4) Stability of resistance, selection of resistant material, economics of control, special problems. Prerequisites: Bot. 22 or 33; 10. Offered in the fall semester of odd years. *Messrs. Wernham and Mills*
518. BOTANICAL PROBLEMS (1-15 per semester) Offered each semester. *Mr. Popp and Staff*
519. PLANT VIRUSES (3) Nature, symptomatology, transmission, and control of virus diseases of plants. Offered in the fall semester of even years. *Mr. Boyle*
520. PLANT PATHOGENIC BACTERIA (3) Bacteria causing plant diseases; methods of identification, inoculation, and control. Offered in the spring semester of odd years. *Mr. Kneebone*
521. MOLDS, YEASTS, AND ACTINOMYCETES (3) Morphology and taxonomy of fungi important in microbiology; identification and techniques of study. Offered in the spring semester of even years. *Mr. Fergus*
522. MYXOMYCETES, PHYCOMYCETES, AND ASCOMYCETES (4) Morphology, taxonomy, phylogeny, and life histories; identification and field work. Prerequisite: Bot. 419. Offered in the fall semester of odd years. *Mr. Fergus*
523. BASIDIOMYCETES AND FUNGI IMPERFECTI (4) Morphology, taxonomy, phylogeny, and life histories. Prerequisite: Bot. 419. Offered in the spring semester of even years. *Mr. Fergus*
524. (Zool. 524). SEMINAR IN GENETICS (1 per semester) Offered each semester. *Messrs. Wright, Grun, and Mitchell*
- 525a,b. STRUCTURE OF ECONOMIC PLANTS (3-6) Developmental and reproductive features of (a) field and vegetable crops, (b) fruit crops. Bot. 525a is offered in the spring semester of odd years, 525b in the spring semester of even years. *Mr. Grove*
526. PHOTOMICROGRAPHY OF PLANT TISSUES (2) Prerequisite: Bot. 421 or Zool. 31 or W.U. 37. Offered in the spring semester of even years. *Mr. Kribs*
- 527a-527b. PLANT BIOLOGY FOR TEACHERS (3 each) (a) Structure and physiology; (b) reproduction processes, development and relationships of plant groups. Methods of obtaining materials and setting up experiments. Designed for teachers and prospective teachers. Prerequisite: general biology or general botany courses. Offered in summer only; a and b given in alternate years.
528. (Zool. 528). POPULATION GENETICS (3) Factors affecting gene frequency, genotype frequency, genotype-environmental interaction, and genetic relationship in natural and artificial populations. Offered in the fall semester of odd years. *Mr. Mitchell*
529. DISEASES OF FORAGE CROPS (3) Etiology, symptomatology, and epidemiology of the more important diseases of forage grasses and legumes; critical evaluation of techniques of control. Offered in the spring semester of even years. *Mr. Couch*
530. PLANT DISEASE CONTROL (3) Methods, and laboratory and field testing of materials used in plant disease control. Offered in the spring semester of even years. *Mr. Fink*
531. PLANT PATHOLOGY SEMINAR (1 per semester) Selected topics of current research, history, and contemporary trends in plant pathology. Offered each semester.

533. (Zool. 533). PROBLEMS IN GENETICS (2-6) Problems to suit needs of individual students; conferences and laboratory work. Prerequisite: Bot. or Zool. 422. *Messrs. Wright, Grun, and Mitchell*
537. (Ed. 537, Zool. 537). WORKSHOP IN THE BIOLOGICAL SCIENCES (3) Projects designed for teachers of biology in the secondary schools. Offered in summer only.

## BUSINESS ADMINISTRATION

G. K. NELSON

*In Charge of Graduate Programs in Business Administration*  
123 Boucke Building

Programs are offered leading to the M.S. and Ph.D. degrees with a major in business administration, and specialization in accounting, banking and finance, insurance and real estate, management, marketing, or trade and transportation. There is also a general major at the master's level for students whose undergraduate training was not business administration.

A minimum of 18 acceptable undergraduate credits in the fields of accounting, commerce, economics, and business statistics—including at least 6 in economics and 3 in business statistics—is required. An applicant who is slightly deficient in the required course work may be admitted with specific deficiencies which must be made up without degree credit. An applicant with little or no undergraduate training in the field of business administration may enroll as an undergraduate student in business administration for one or more semesters and then be admitted to the Graduate School if his record is satisfactory.

### ACCOUNTING (ACCTG)

- |                                                                                                                                                                                          |                         |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| 400. CONTROLLERSHIP (3)                                                                                                                                                                  | <i>Mr. G. K. Nelson</i> |
| 401. ADVANCED ACCOUNTING (3)                                                                                                                                                             | <i>Mr. Schrader</i>     |
| 403. ADVANCED AUDITING (3-9)                                                                                                                                                             | <i>Mr. Rowland</i>      |
| 404. BUDGETARY CONTROL (3)                                                                                                                                                               | <i>Mr. G. K. Nelson</i> |
| 405. ADVANCED COST ACCOUNTING (3)                                                                                                                                                        | <i>Mr. G. K. Nelson</i> |
| 406. ADVANCED FEDERAL TAX ACCOUNTING (3)                                                                                                                                                 | <i>Mr. Rowland</i>      |
| 407. C.P.A. REVIEW (3)                                                                                                                                                                   | <i>Mr. Rowland</i>      |
| 408, 408X. GOVERNMENTAL ACCOUNTING (3)                                                                                                                                                   | <i>Mr. Rowland</i>      |
| 500. ACCOUNTING SEMINAR (3)                                                                                                                                                              |                         |
| 501. ACCOUNTING SYSTEMS (3) Principles of system design including practical application to special businesses, such as financial institutions, department stores, public utilities, etc. |                         |
| 520. PROBLEMS IN ACCOUNTING (3-6) Planned individual projects involving library, laboratory, or field work.                                                                              |                         |

### COMMERCE (COM)

- |                                           |                    |
|-------------------------------------------|--------------------|
| 405. ANALYSIS OF FINANCIAL STATEMENTS (3) | <i>Mr. Bradley</i> |
| 406. INVESTMENT ANALYSIS (3)              | <i>Mr. Malott</i>  |



- |                                                                                                                                                                                                                                            |                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| 407. INVESTMENT BANKING (3)                                                                                                                                                                                                                | <i>Mr. Bradley</i>  |
| 415. REGULATION OF TRANSPORT CARRIERS (3)                                                                                                                                                                                                  | <i>Mr. Pashek</i>   |
| 416. PROBLEMS IN TRADE AND TRANSPORTATION (3)                                                                                                                                                                                              | <i>Mr. Waters</i>   |
| 417. FOREIGN MARKETS (3)                                                                                                                                                                                                                   | <i>Mr. Mares</i>    |
| 424. MARKETING RESEARCH (3)                                                                                                                                                                                                                | <i>Mr. Beik</i>     |
| 427. RETAIL BUYING AND MERCHANDISING (3)                                                                                                                                                                                                   | <i>Mr. Einstein</i> |
| 428. RETAIL ADVERTISING AND SALES PROMOTION (3)                                                                                                                                                                                            | <i>Mr. Einstein</i> |
| 430. ADVANCED BUSINESS LAW (3)                                                                                                                                                                                                             | <i>Mr. Phalan</i>   |
| 434. ADVANCED PROPERTY AND CASUALTY INSURANCE (3)                                                                                                                                                                                          | <i>Mr. Lucas</i>    |
| 435. ESTATE PLANNING (3)                                                                                                                                                                                                                   | <i>Mr. Williams</i> |
| 436. FUNDAMENTALS OF SALES MANAGEMENT (3)                                                                                                                                                                                                  | <i>Mr. Decker</i>   |
| 437. CASE STUDIES IN MARKETING (3)                                                                                                                                                                                                         | <i>Mr. Babione</i>  |
| 455. CASES IN PUBLIC RELATIONS (3)                                                                                                                                                                                                         | <i>Mr. Wherry</i>   |
| 477. ADMINISTRATIVE MANAGEMENT (3)                                                                                                                                                                                                         | <i>Mr. Richards</i> |
|                                                                                                                                                                                                                                            |                     |
| 500. CASE STUDIES IN BUSINESS ADMINISTRATION (3) Case studies of business and management policy with respect to procurement, production, selling, finance, accounting, relations with government, labor, and the public.                   | <i>Mr. Waters</i>   |
| 501. COMMERCE SEMINAR (3-6) Reports on research in selected fields of commercial activities.                                                                                                                                               | <i>Mr. Waters</i>   |
| 502. SEMINAR IN BUSINESS MANAGEMENT (3-6)                                                                                                                                                                                                  | <i>Mr. Waters</i>   |
| 503. TRANSPORTATION AND PUBLIC UTILITY SEMINAR (3-6)                                                                                                                                                                                       | <i>Mr. Cook</i>     |
| 504. PROBLEMS IN COMMERCE (3-6) Planned individual projects involving library, laboratory, or field work.                                                                                                                                  | <i>Mr. Leffler</i>  |
| 506. SEMINAR IN INVESTMENTS AND CORPORATION FINANCE (3-6)                                                                                                                                                                                  | <i>Mr. Leffler</i>  |
| 517. INTERNATIONAL BUSINESS PRACTICES (3) Practices of exporters and importers dealing in commodities traded in world markets under competition, monopoly, or governmental control. Prerequisite: Com. 17.                                 | <i>Mr. Hench</i>    |
| 523. SEMINAR IN MARKETING (3-6) Research in modern marketing trends.                                                                                                                                                                       | <i>Mr. Babione</i>  |
| 525. CASE STUDIES IN INSURANCE (3-6) Analysis of management's insurance problems, such as the feasibility of self-insurance; proper allocation of insurance premiums and coverage in selected industries, etc. Prerequisites: Com. 25, 33. | <i>Mr. Wherry</i>   |
| 536. SALES MANAGEMENT SEMINAR (3) Principles of sales planning and administration; co-ordination of selling with advertising, promotion, production, and accounting; use of market research selling costs and budgets.                     |                     |

## CERAMIC TECHNOLOGY

G. W. BRINDLEY, *Head of the Department*  
214 Mineral Industries Building

The M.S. and Ph.D. degrees are offered in ceramic technology. The background required for admission is a bachelor's degree in ceramics or in one of the related

## CERAMIC TECHNOLOGY

physical sciences. A knowledge of differential and integral calculus is required together with adequate physics and chemistry.

In view of the wide field covered by ceramic technology, the graduate courses may be selected with a bias toward physical ceramics, chemical ceramics, or glass technology. This makes it easily possible for students whose major subject for the B.S. or M.S. degree has been either physics or chemistry to take appropriate graduate studies in ceramic technology.

Special facilities exist for research in the areas of clay mineralogy, phase diagram and related studies, ferrite and ferroelectric studies, and glass technology.

### CERAMIC TECHNOLOGY (CER T)

400. SPECIAL TOPICS (1-2)  
401. CERAMIC BODIES AND GLAZES (3) *Mr. Hummel*  
402. PRINCIPLES OF CERAMIC ENGINEERING (3)  
403. CERAMIC ENGINEERING PROCESSES AND EQUIPMENT (3)  
404. CERAMIC SEMINAR (1)  
405. CERAMIC RESEARCH AND DESIGN (3)  
411. THEORY OF CERAMIC PROCESSES (2) *Mr. Buessem*  
413. CERAMIC PETROGRAPHY (3)  
415. GLASS AND ENAMELS (3) *Mr. Ehman*  
416. ADVANCED GLASS TECHNOLOGY (3) *Messrs. Weyl and Rindone*  
420. REFRACTORIES (3) *Mr. McQuarrie*
500. SEMINAR IN CERAMIC TECHNOLOGY (1-2 per semester) Current developments in ceramic technology and related fields. Required of all graduate students in ceramic technology. *Mr. Brindley and Staff*
501. COLLOIDAL BEHAVIOR OF CLAYS AND MUDS (2-4) Colloidal properties of ceramic clays, glazes, drilling muds, filtering and bleaching clays, and kindred systems. *Mr. Taylor*
503. USE OF PHASE EQUILIBRIA DATA IN CERAMIC TECHNOLOGY (2-5) Phase equilibria in unary, binary, ternary, and other systems; applications in product development and in understanding behavior of ceramic materials. *Mr. Hummel*
506. MECHANICAL PROPERTIES OF CERAMIC MATERIALS (2-3) Experimental stress-strain-time relations in elasticity, anelasticity, plasticity, and rupture; theory of strength and control. *Mr. Buessem*
507. THERMAL PROPERTIES OF CERAMIC MATERIALS (2-3) Heat capacity, heat of fusion, thermal conductivity, and thermal expansion in relation to macroscopic measurements and basic atomic concepts applied to ceramic materials.
508. DIELECTRIC AND MAGNETIC PROPERTIES OF CERAMIC MATERIALS (2-3) Preparation and properties of ceramic semi-conductors, dielectrics, and magnetic materials. *Mr. Buessem*
510. SEMINAR IN GLASS TECHNOLOGY (1-2 per semester) Current developments in glass technology and related fields. *Mr. Weyl and Staff*
511. CHEMICAL ASPECTS OF THE CONSTITUTION OF GLASS (1-3 per semester) Historical development, properties, and atomistic interpretation for changes of properties with compositions, temperature, and past history. *Mr. Weyl*

## CERAMIC TECHNOLOGY

512. PHYSICAL ASPECTS OF THE CONSTITUTION OF GLASS (1-3) Atomic structure of glass, its relation to physical properties; rheology; glass as a liquid. *Mr. Brindley*
515. SPECIAL PROBLEMS IN CERAMIC TECHNOLOGY (1-6 per semester) Advanced individual study on a problem in ceramics.
516. SELECTED TOPICS IN CERAMIC TECHNOLOGY (1-3 per semester) Intensive group study of special topics.
517. RESEARCH INSTRUMENTS AND EQUIPMENT (2) Applications of fundamental laws and principles in research instruments; care, adjustment, and effective use of instruments and equipment (demonstrations).
530. (Min. 530). STRUCTURE, PROPERTIES, AND OCCURRENCE OF CLAY MINERALS (2-5) Structure analysis and identification of clay minerals; mineral transformation and behavior; occurrence, genesis, and petrography of fine-grained sediments.  
*Messrs. Brindley, Bates, and Griffiths*

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in ceramic technology studies are listed under Mineral Sciences in Part II of this bulletin. The subject of color in glasses is treated in Min. 521.

## CHEMICAL ENGINEERING

FLOYD L. CARNAHAN, *Acting Head of the Department*  
102 Walker Laboratory

Graduate work in this department leads to the M.S. or Ph.D. degrees. The minimum undergraduate requirements for admission are 24 semester hours of chemical engineering including stoichiometry, industrial chemistry, unit operations, thermodynamics, plant design, kinetics, or chemical engineering problems; 14 semester hours of engineering including engineering mechanics, electrical engineering, or mechanical engineering basic courses; chemistry through one year of physical chemistry; and mathematics through differential equations.

### CHEMICAL ENGINEERING (CH E)

- |                                                      |                     |
|------------------------------------------------------|---------------------|
| 402. CHEMICAL ENGINEERING (4)                        | <i>Mr. Carnahan</i> |
| 403. CHEMICAL ENGINEERING (4)                        | <i>Mr. Carnahan</i> |
| 404. CHEMICAL PLANT DESIGN (3)                       | <i>Mr. Williams</i> |
| 405. THERMODYNAMICS FOR CHEMICAL ENGINEERS (3)       | <i>Mr. Cannon</i>   |
| 406. CHEMICAL ENGINEERING PROBLEMS (3)               |                     |
| 420. CRYOGENIC ENGINEERING (3)                       | <i>Mr. Fritz</i>    |
| 422. MOTOR FUELS (2)                                 | <i>Mr. Carnahan</i> |
| 430. CHEMICAL TECHNOLOGY IN THE NUCLEAR INDUSTRY (3) |                     |
500. SEMINAR IN CHEMICAL ENGINEERING (1) Required of all graduate students.
510. ADVANCED HEAT TRANSFER I (3) Physical and chemical factors controlling the rate of heat transfer under conditions of steady flow.
511. ADVANCED HEAT TRANSFER II (3) Flow of heat under varying temperature conditions.



## CHEMICAL ENGINEERING

515. DISTILLATION (3) Commercial distillation, equilibrium diagrams, vapor composition, stills and rectifying and stripping columns. *Mr. Carnahan*
516. ECONOMIC BALANCE (3) Problem work on the design of chemical engineering equipment from the economic standpoint. *Mr. Cannon*
518. CHEMICAL ENGINEERING DESIGN (3) Complicated examples are discussed and worked out. Several different unit operations will be combined for the design of a complete installation.
520. EXTRACTION PROCESSES (3) Equilibrium extraction data and phase contacting and settling related to equipment design.
521. MASS TRANSFER (3-12) Problem course on developments in diffusion, fluid dynamics, phase equilibrium, process kinetics, and control; use of digital and analog computers.
524. CHEMICAL ENGINEERING, APPLICATION OF THERMODYNAMICS (3) Elements of thermochemistry and thermodynamics of greatest importance in chemical engineering. *Mr. Cannon*
530. HEAT TRANSFER IN NUCLEAR REACTORS (3) Fluid flow, heat transfer, and design problems in nuclear reactor systems.

## CHEMISTRY

W. CONARD FERNELIUS, *Head of the Department*  
212 Whitmore Laboratory

The department offers graduate work leading to the M.Ed., M.S., D.Ed., and Ph.D. degrees. Students may specialize in analytical, inorganic, organic, physical, and petroleum chemistry. The general facilities for instruction and research in the major fields of chemistry are excellent, while the cryogenic, microscopy, petroleum, radiochemical, and spectroscopy laboratories provide a number of unusual features.

Entering graduate students should have had training which includes at least one year's work in each of the following: general chemistry, analytical chemistry, organic chemistry, physical chemistry, and general physics. Mathematics through integral calculus is required, and a reading knowledge of at least one foreign language, preferably German, is expected.

Prior to scheduling their first semester's program, new students will take examinations in the four areas of analytical, inorganic, organic, and physical chemistry. The information obtained from these tests will assist both the student and his adviser in making up a program best suited to the entering student's needs. These examinations are normally given just prior to the regular registration period.

### CHEMISTRY (CHEM)

400. CHEMICAL LITERATURE (1) *Mrs. Strauss*
401. SEMINAR (1)
405. NUCLEAR AND RADIOCHEMISTRY (3) Breakage ticket \$5.  
*Messrs. Currie and Miller*
410. ADVANCED INORGANIC CHEMISTRY (4) Breakage ticket \$5.
- 411-412. FLUORINE CHEMISTRY (3 each)



## CHEMISTRY

526. MODERN INSTRUMENTAL ANALYSIS (3) *Messrs. Hayes, Jordan, and Schempf*
527. SPECIAL TOPICS IN ANALYTICAL CHEMISTRY (2-12)  
*Messrs. Hayes, Jordan, and Schempf*
531. SPECIAL TOPICS IN ORGANIC CHEMISTRY (3-12)
532. ORGANIC NITROGEN COMPOUNDS (3) Chemistry, stereochemistry, and molecular structure of organic compounds containing nitrogen. *Mr. Aston*
534. THEORETICAL ORGANIC CHEMISTRY (3) Modern theories of structure; resonance; interpretation of physical properties; theory of rates; equilibrium properties. *Mr. Aston*
- 535-536. ORGANIC CHEMISTRY (3 each) Adapted to the needs of those doing research work in organic chemistry. *Mr. Zook*
537. ORGANIC CHEMISTRY OF HIGH POLYMERS (3) High polymer theory and practice from the viewpoint of organic chemistry. *Mr. Sommer*
538. ORGANIC CHEMISTRY (3) Survey of organic chemistry arranged primarily for graduate students majoring in fields other than organic chemistry.  
*Messrs. Noll and Oakwood*
539. STEREOCHEMISTRY (3) Comprehensive treatment of the principles of stereochemistry as applied to organic compounds. *Mr. Oakwood*
540. EXPERIMENTAL METHODS OF PHYSICAL CHEMISTRY (3-5)
541. PHASE RULE (3) The phase rule and its applications.
542. COLLOIDS (3) The physics and chemistry of surfaces and their resulting colloid properties; methods of preparing colloids. *Mr. Smith*
544. CHEMICAL THERMODYNAMICS (3) Development of thermodynamic theory with special reference to common physical changes and chemical reactions. Prerequisite: Chem. 441 or 562. *Messrs. Aston and Fritz*
545. CHEMICAL THERMODYNAMICS AND INTRODUCTORY STATISTICAL MECHANICS (3) Continuation of Chem. 544 including the calculation of thermodynamic properties from molecular and spectroscopic data. Prerequisite: Chem. 544. *Messrs. Aston and Fritz*
546. QUANTUM CHEMISTRY (3) Theory of energy levels in atoms and molecules from the standpoint of wave mechanics with special emphasis on the portion of the subject applying to common chemical systems. Prerequisite: Chem. 441 or 562. Given alternate years only. *Mr. Aston*
547. STATISTICAL MECHANICS (3) Properties of matter at equilibrium, developed on the basis of energy levels of molecules and statistical mechanical theory. Prerequisite: Chem. 546. Given alternate years only. *Mr. Aston*
548. CATALYSIS (3) Theory of catalysis and its application to industry.
549. PHYSICAL CHEMISTRY OF HIGH POLYMERS (3) Physicochemical principles related to the properties of synthetic and natural polymeric systems. *Mr. Woodward*
560. TOPICS IN PHYSICAL CHEMISTRY (3-12)



- 561-562. CHEMICAL PRINCIPLES (3 each) Mathematical treatment of the classical principles of chemistry; their application to problems. Required of all graduate students. Prerequisites: Chem. 461, Math. 43, Phys. 285. A course in organic chemistry is recommended. *Messrs. Seward, Fritz, Ascah, and Taft*
563. CHEMICAL KINETICS (3) Theory and measurement of the rates of chemical reactions; the mechanism of chemical reactions. *Messrs. Ascah and Taft*
564. CHEMICAL KINETICS (3) Continuation of Chem. 563 but including theory and measurement of photochemical reactions. *Messrs. Ascah and Taft*
565. ATOMIC AND MOLECULAR STRUCTURE (3) Structure of chemical species and correlation of experimentally determined properties by structural theory.
567. ADVANCED THEORETICAL CHEMISTRY (3) Modern and current theories of the properties of chemical substances and their applications to chemical problems; the construction of chemical theory.
581. EXPERIMENTAL METHODS IN PETROLEUM CHEMISTRY (1-12)
582. TOPICS IN PETROLEUM CHEMISTRY (2-6)

## CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS

WINONA L. MORGAN, *Head of the Department*  
19A Home Economics Building

The M.S. and M.Ed. degrees are offered in the general field of child development and family relationships. The Ph.D. and D.Ed. degrees are offered in either child development or family relationships.

Students may specialize in the guidance and development of children, relationships among various members of the family, problems of all stages of the family cycle, nursery school education, education for home and family living in the schools, parental education, and work with children and families in community agencies.

The entering student should have had at least 6 credits in the physical and biological sciences, 12 in the social sciences (which must include a basic course in sociology and one in psychology), and 6 in child development and family relationships. Students who are otherwise qualified but who lack some of these credits may be admitted and permitted to make up the deficiency credits along with a graduate program.

### CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS (CD FR)

405. MARRIAGE AND FAMILY RELATIONSHIPS (3) *Mr. Smith*
- 429, 429X. CHILD DEVELOPMENT (3) *Miss Avery*
430. OBSERVATION AND EXPERIENCE IN NURSERY SCHOOL (1-4)
- 440, 440X. STUDY OF LATER CHILDHOOD (3) *Miss Avery*
441. NURSERY SCHOOL ORGANIZATION (3) *Miss Morgan*
445. (Psy. 445). DEVELOPMENT THROUGHOUT ADULthood (3) *Mr. Smith*
481. EDUCATIONAL METHODS WITH PRESCHOOL CHILDREN (3)
482. EDUCATIONAL PROCEDURES IN CHILD DEVELOPMENT AND FAMILY RELATIONS (3) *Miss Morgan*

## CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS

508. PARENTAL EDUCATION (3) Discussion and use of methods, experiences, and programs which can be used effectively to help parents in dealing with problems of parent-child relationships. Prerequisites: C.D.F.R. 429, 430. *Miss Morgan*
- 515, 515X. THE TEACHING OF CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS (3) Methods of selection and presentation of subject matter basic to understanding the development of children, and the attitudes, emotions, and relationships within the family. Not open to students having credit for C.D.F.R. 482. Prerequisite: 6 credits in child development and family relationships. *Miss Morgan*
529. (Psy. 529). SEMINAR IN CHILD DEVELOPMENT (1-6) Readings and reports on recent findings in child development. Prerequisites: 6 credits in child development or 6 in educational or child psychology, plus 3 in statistics. *Miss Morgan*
530. PROBLEMS IN CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS (1-6) Problems involving individual research in library, laboratory, or field projects.
536. CHILDREN IN POSTWAR FAMILIES AND COMMUNITIES (3) Postwar family and community situations influencing the development of children; the role of parents and teachers in helping individual children make satisfactory adjustments. Prerequisites: C.D.F.R. 429, 430, or 2 courses in psychology. *Miss Morgan*
- 545, 545X. THE FAMILY IN ITS COMMUNITY (2-3) Cultural influences on family relationships; how the family orients its members to community living and group participation. Prerequisites: Soc. 1, C.D.F.R. 405; R.Soc. 452 or Psy. 419. *Mr. Smith*
546. SEMINAR IN FAMILY RELATIONSHIPS (1-3) Reading, reports, and discussion of recent research in relationship aspects of family living; particular attention to studies of roles, crises, and adjustments within the family setting. Prerequisite: C.D.F.R. 405 or 6 credits in sociology or psychology. *Mr. Smith*

## CIVIL ENGINEERING

BENJAMIN A. WHISLER, *Head of the Department*  
208 Sackett Building

Graduate work leading to the M.S. and Ph.D. degrees is offered. The entering student should be a graduate in civil engineering from an accredited college of engineering. Students may specialize in structures, hydraulics, transportation engineering, surveying and sanitary engineering, or combinations of these, through courses offered both by the Department of Civil Engineering and by other departments of the University.

### CIVIL ENGINEERING (C E)

400. SEMINAR (1-3)  
401. CIVIL ENGINEERING PROJECTS (2-12)  
412. ADVANCED PHOTOGRAMMETRY (3)  
421. HIGHWAYS AND STREETS (3)  
423. HIGHWAY SAFETY AND TRAFFIC CONTROL (3)  
431. CIVIL ENGINEERING CONSTRUCTION (3)  
441. STATICALLY INDETERMINATE STRUCTURES (3)  
442, 442X. STATICALLY INDETERMINATE STRUCTURES (3)

- 443. PHOTOELASTICITY AND MODEL ANALYSIS (3)
- 444, 444X. SOIL MECHANICS AND FOUNDATIONS (3)
- 446. ADVANCED SOIL MECHANICS (3)
- 451, 451X. ADVANCED HYDROLOGY (3)
- 462, 462X. ADVANCED HYDRAULICS (3)
- 465. ELEMENTS OF HYDRAULIC ENGINEERING (3)
- 466. HYDRAULIC MACHINERY (3)
- 471. MUNICIPAL AND RURAL SANITATION (3)
- 472. TREATMENT PLANTS (4)
- 473. WATER AND SEWAGE ANALYSIS (3)
- 474. SANITARY ENGINEERING PROBLEMS (1-6)
  
- 500. SEMINAR IN CIVIL ENGINEERING (1-6) Reports on researches and special topics. Course may be continued in subsequent semesters.
  
- 521. TRANSPORT PLANNING AND DESIGN (2-6) Planning and design of transportation facilities; basic principles and engineering techniques applied to airways, highways, pipe lines, railways, waterways. Prerequisite or concurrent: C.E. 51, 421, 422, or 481.
  
- 522. TRANSPORT OPERATION AND MAINTENANCE (2-6) Engineering problems in operation, maintenance, and administration of airways, highways, pipe lines, railways, waterways. Prerequisite or concurrent: C.E. 51, 421, 422, or 481.
  
- 540. ADVANCED STRUCTURAL ANALYSIS (2-4) Geometry of flexure, deflections; analysis of continuous beams, rigid frames, arches; influence lines. Prerequisite: C.E. 40.
  
- 541. ADVANCED STRUCTURAL ANALYSIS (2-4) Truss deflection; trusses with redundant members, continuous trusses, framed arches; influence lines; secondary stresses; wind stresses; space framework; suspension bridges. Prerequisite: C.E. 40.
  
- 542. APPLIED SOIL MECHANICS (2-5) Soil classification by type of clay minerals and profile development; aerial photographic interpretation of soils and applications to site selection for dams, highways, and airports. Prerequisites: C.E. 412, 444, Geol. 71.
  
- 543. STRUCTURAL ENGINEERING PROJECTS (3-10) Investigation or design projects in concrete, soil mechanics, photoelasticity, analysis, etc. Prerequisite or concurrent: C.E. 441, 442.
  
- 544. ADVANCED STRUCTURAL DESIGN (2-4) Plain and reinforced concrete design as applied to buildings, bridges, retaining walls, domes, tanks, and dams; prestressed concrete. Prerequisites: C.E. 42, 442.
  
- 545. ADVANCED STRUCTURAL DESIGN (2-4) Structural steel design as applied to riveted and welded girders, trusses, rigid frames, wind connections; timber design. Prerequisite: C.E. 41.
  
- 550. ENGINEERING CONSTRUCTION (2-4) Construction methods applied to foundations, buildings, bridges, and other civil engineering construction work. Prerequisites: C.E. 41, 42.
  
- 551. HYDROLOGIC INVESTIGATIONS (2-8) Application of hydrologic principles and techniques to a specific project. Prerequisite: C.E. 451.
  
- 560. THEORY OF HYDRAULIC MODELS (3) Application of dimensional analysis and similitude to models used in the study of problems in hydraulics.



## CIVIL ENGINEERING

565. TRANSPORTATION OF SOLIDS BY FLUIDS (2-5) Fundamentals of the flow of solids in open and closed conduits; e.g., suspended load and bed load in rivers, slurries and pulp stocks in pipes.
566. FLUID MECHANICS OF HYDRAULIC MACHINERY (3) Advanced theory and design of hydraulic machinery. Prerequisite: C.E. 466.
568. THEORETICAL HYDRODYNAMICS (3-6) Fundamental equations of fluid motion, stream function, velocity potential, flow nets, transformations, motion of viscous fluids, applications.
570. RURAL SANITATION DESIGN (3) Requirements and devices essential to rural sanitary problems: water supply, excreta disposal, industrial waste treatment. Not intended for civil or sanitary engineering students. Prerequisites: Chem. 4, Phys. 285.
571. WATER PURIFICATION AND SOFTENING (3) Current methods of softening, disinfecting, and conditioning water for municipal and industrial use. Prerequisite: C.E. 70.
572. SEWAGE TREATMENT (3) Modern methods of sewage treatment. Prerequisite: C.E. 70.
573. ADVANCED PROBLEMS IN SANITARY ENGINEERING (3-10) Continuation of C.E. 474 on a graduate level. Prerequisite: C.E. 474.
575. ADVANCED INDUSTRIAL WASTE TREATMENT (3) Techniques of industrial waste treatment; attendant stream pollution and stream self-purification factors. Prerequisite: C.E. 472 or 572.
576. WATER TREATMENT PLANT DESIGN (1-6) Design of works for treatment of water for municipal and industrial use. Prerequisite: C.E. 71.
577. SEWAGE TREATMENT PLANT DESIGN (1-6) Design of works for treatment of sewage or industrial wastes. Prerequisite: C.E. 71.
578. INDUSTRIAL HYGIENE (3) Principles of control of industrial toxics and the protection of the worker and the community.
579. PUBLIC HEALTH ADMINISTRATION (3) Operation and duties of health departments at the various levels.

## CLINICAL SPEECH

EUGENE T. McDONALD, *Director of the Speech and Hearing Clinic*  
25 Sparks Building

The Speech and Hearing Clinic offers graduate training leading to the M.Ed., M.S., D.Ed., and Ph.D. degrees. Students may specialize in either speech correction or audiology.

Admission to study for either master's degree requires 27 semester hours in clinical speech and hearing, education, and psychology courses. These must include at least 9 credits in speech correction and/or audiology. Applicants for the M.Ed. degree must have had student teaching. Applicants for the M.S. degree may count credits in speech science toward the required 27 hours.

## SPEECH EDUCATION (SP ED)

430. HEARING PROBLEMS AND THE TESTING OF HEARING (3)  
 434. AUDIOMETRY AND HEARING AIDS (3)  
 435. CLINICAL PRACTICE WITH THE HEARING HANDICAPPED (1-6)  
     *Unit A. Audiologic Evaluation and the Selection of Hearing Aids (1-4)*  
     *Unit B. Auditory Training and Speech Reading (1-4)*  
 436. INTRODUCTION TO SPEECH CORRECTION (3)  
 437. CLINICAL PRACTICE IN SPEECH CORRECTION (1-3)  
 439X. FUNDAMENTALS OF SPEECH EDUCATION (3)  
 439aX. METHODS IN SPEECH EDUCATION (3)  
 440, 440X. SPEECH EDUCATION FOR THE CLASSROOM TEACHER (2-3)  
 441. CURRENT PROBLEMS IN SPEECH AND HEARING (1-6)  
 442. SPEECH PATHOLOGY (3)  
 443. METHODS IN AUDITORY TRAINING AND SPEECH READING (3)  
 445. THE PUBLIC SCHOOL SPEECH CORRECTION PROGRAM (3)  
 525. SEMINAR IN CLINICAL SPEECH PATHOLOGY (3-9) Prerequisites: Sp.Ed. 436, 442.  
     *Unit A. Cleft Palate*  
     *Unit B. Cerebral Palsy*  
     *Unit C. Aphasia*  
 530. SEMINAR IN AUDIOLOGY (2-4) Review of theories of hearing and review of related physiological and psychological researches. Prerequisite: Sp.Ed. 434.  
 537. ADVANCED CLINICAL PRACTICE IN SPEECH CORRECTION (1-9) Prerequisites: Sp.Ed. 437, 442.  
     *Unit A. Diagnostic Procedures (1-3)*  
     *Unit B. Treatment Procedures (1-6)*  
 540. ARTICULATION DISABILITIES (3) Speech-sound production disorders in children and adults; methods of examination, diagnosis, and treatment. Prerequisites: Sp.Ed. 437, 442.  
 541. THE VOICE AND ITS DISORDERS (3) Physical, physiological, and psychological bases of voice production; causes, nature, and symptoms of its disorders; current clinical methods in voice improvement. Prerequisites: Sp.Ed. 437, 442.  
 542. STUTTERING AND ALLIED DISORDERS (3) Modern theories of causes of disorders of rhythm; methods of examination, diagnosis, and treatment. Prerequisites: Sp.Ed. 437, 442.  
 543. DIAGNOSTIC PROCEDURES IN CLINICAL SPEECH (3) Clinical instrumentation; case history taking; examination procedures and materials used in diagnosing speech disabilities; interpretation of findings; report preparation. Prerequisites: Sp.Ed. 437, 442.

## CLOTHING AND TEXTILES

RUTH W. AYRES, *Head of the Department*  
 116A Home Economics Building

A graduate major in clothing and textiles may lead to an M.S., M.Ed., Ph.D., or D.Ed. degree. Work may be taken with major emphasis on the textile side, which stresses the background natural sciences, or on the clothing side, which stresses the

## CLOTHING AND TEXTILES

background social sciences. Candidates are accepted who have a strong background and a good record in home economics, chemistry, sociology, economics, or psychology.

### CLOTHING AND TEXTILES (CL TX)

- 402, 402X. FUNDAMENTAL PRINCIPLES OF TAILORING CONSTRUCTION (3)
- 403. CREATIVE PATTERN MAKING (3)
- 404. DRAPING (3)
- 405, 405X. FASHION MERCHANDISING (3)
- 406. FASHION PROMOTION (3)
- 407. THE TEXTILE AND CLOTHING INDUSTRY (3)
- 408. INTERMEDIATE TEXTILES (3)
- 410. CLOTHING FOR THE FAMILY (3)
- 411. ADVANCED CLOTHING CONSTRUCTION (3)
- 413. TEXTILE TECHNOLOGY (3)
  
- 503. ADVANCED PATTERN DEVELOPMENT (3) Analysis of advanced pattern designing principles to give students facility in original designing.
- 504. ADVANCED DRAPING (3) Analysis of principles and techniques as a basis for creation of original designs; survey of literature in dress design.
- 505, 505X. CLOTHING INSTRUCTIONAL MATERIALS (3) Development of instructional materials and techniques based on needs of diverse groups.
- 506. THE FASHION WORLD (3)
- 507. PROBLEMS IN RELATION TO CLOTHING CONSUMPTION (3) Problems connected with manufacture and consumption of clothing; interrelation of textile and clothing trades with other industries.
- 508. SPECIAL PROBLEMS IN CLOTHING AND TEXTILES (1-6) Individual directed study, investigation, and practice in selected phases of textiles and clothing.
- 509, 509X. SEMINAR IN CLOTHING AND TEXTILES (1-6)
- 510. RESEARCH METHODS AND EVALUATION IN CLOTHING AND TEXTILES (1-6)
- 511. CURRENT DEVELOPMENTS IN CLOTHING AND TEXTILES (1-6)
- 512. HISTORY OF CLOTHING AND CLOTHING CONSTRUCTION (3)
- 513. ADVANCED TEXTILE TECHNOLOGY (6)

## COMPARATIVE LITERATURE

PHILIP A. SHELLEY

*Chairman of the Committee on Comparative Literature*  
229 Sparks Building

Graduate study in comparative literature may lead to the M.A. and Ph.D. degrees. Programs are arranged through a meaningful selection of courses offered by the several departments of languages and literatures, both ancient and modern, as well as



## COMPARATIVE LITERATURE

of those specifically in the category of comparative literature. More than a minimum knowledge of foreign languages is required.

### COMPARATIVE LITERATURE (C LIT)

400. COMPARATIVE METHOD IN LITERARY STUDIES (3)  
443. (Ger. 443). LITERARY RELATIONS OF GERMANY WITH ENGLAND AND AMERICA  
(3-9) *Mr. Shelley*  
480. INTRODUCTION TO FOLKLORE (3) *Mr. Bayard*  
500. SEMINAR IN COMPARATIVE LITERATURE (3-6)

## DAIRY SCIENCE

DONALD V. JOSEPHSON, *Head of the Department*  
105 Dairy Building

Graduate programs lead to the M.S. and Ph.D. degrees with specialization in dairy products manufacture, chemistry of milk and dairy products, dairy cattle nutrition, dairy cattle management, and physiology of reproduction. The minor program is generally taken in agricultural and biological chemistry, bacteriology, zoology, or agricultural economics.

Prerequisite to graduate work is the completion of an undergraduate curriculum in dairy science or a related science area. The undergraduate program must include college algebra and general physics. Students may be admitted with limited deficiency but are required to make up undergraduate deficiency work without degree credit.

### DAIRY SCIENCE (D SC)

418. DAIRY SURVEY (1) *Mr. Josephson*  
421. DAIRY MANUFACTURING PROBLEMS (1-6) *Mr. Doan and Staff*  
427. MILK SECRETION (3) *Mr. Kesler*  
428. DAIRY PRODUCTION PROBLEMS (1-3) *Mr. Kesler and Staff*  
430. TECHNICAL CONTROL OF DAIRY PRODUCTS (4) *Mr. Watrous*  
431. PHYSIOLOGY OF REPRODUCTION IN FARM ANIMALS (3) *Mr. Almquist*  
501. BUTTER AND CHEESE (1-6) Manufacture and handling of butter and cheese.  
Prerequisites: D.Sc. 10, 23, Bact. 8, A.B.Ch. 403.  
502. CONDENSED MILK AND MILK POWDER (1-6) Condensing and drying of milk.  
Prerequisites: D.Sc. 10, 26, Bact. 8, A.B.Ch. 403. *Mr. Doan*  
503. PUBLIC MILK PROBLEMS (1-6) Handling milk in modern plants. Prerequisites:  
D.Sc. 11, Bact. 8, A.B.Ch. 403. *Mr. Doan*  
504. ICE CREAM MANUFACTURE (1-6) Manufacture of ice cream, ices, and other  
frozen milk products. Prerequisites: D.Sc. 11, Bact. 8, A.B.Ch. 403. *Mr. Keeney*  
505. DAIRY PLANT ECONOMICS (1-6) Economic factors involved in creamery opera-  
tion and management. Prerequisites: D.Sc. 7, 11. *Mr. Watrous*

## DAIRY SCIENCE

507. DAIRY CATTLE MANAGEMENT (1-6) Management of dairy cattle. Prerequisite: D.Sc. 27. *Mr. Williams and Staff*
508. DAIRY SEMINAR (1-6) Preparation and presentation of a paper on an assigned subject.
509. TESTING DAIRY PRODUCTS (1-6) Constituents of dairy products. Prerequisites: D.Sc. 11, Bact. 8, A.B.Ch. 403. *Mr. Doan*
510. DAIRY CATTLE FEEDING (1-6) Application of fundamental research in animal nutrition to the feeding of dairy cattle. Prerequisites: D.Sc. 1, 29. *Mr. Williams*
511. DAIRY CATTLE NUTRITION (1-6) Nutritional requirements of dairy cattle. Prerequisites: A.Ntr. 401, 402. *Mr. Kesler*
512. ADVANCED STUDIES IN MILK SECRETION (1-6) Physiology of milk secretion. Prerequisite: D.Sc. 427. *Mr. Kesler*
513. DAIRY CATTLE SELECTION (1-6) Breed history, pedigrees, selection and judging of dairy cattle. Prerequisites: D.Sc. 1, 30.
515. ADVANCED PHYSIOLOGY OF REPRODUCTION IN FARM ANIMALS (1-6) *Mr. Almquist*
516. ARTIFICIAL BREEDING OF FARM ANIMALS (1-6) Prerequisite: D.Sc. 431. *Mr. Almquist*
517. DAIRY SCIENCE LITERATURE (1-6) Review and reporting of dairy literature. *Mr. Josephson and Staff*
522. RESEARCH PROCEDURES IN DAIRY TECHNOLOGY (3) Research problems and methods in dairy technology with major emphasis on dairy chemistry. Prerequisite: A.B.Ch. 403. *Mr. Patton*

## ECONOMICS

HOWARD A. CUTLER, *Head of the Department*  
124 Boucke Building

Graduate work leading to the M.A. and Ph.D. degrees is offered. Opportunities are available for concentration in business statistics, economic theory, labor, international economics, government economic policy, money, credit, and public finance.

To enter graduate work in economics a student should have completed 6 credits in economic principles, 9 in the social sciences, and either 3 in statistics or 6 in mathematics.

### BUSINESS STATISTICS (B S)

500. SEMINAR IN BUSINESS STATISTICS (3) *Mr. Saylor*
501. ADVANCED BUSINESS STATISTICS (3) *Mr. Saylor*

### ECONOMICS (ECON)

400. HISTORY OF ECONOMIC THOUGHT (3) *Mr. Herman*
404. ECONOMIC FRAMEWORK OF MODERN SOCIETY (3) *Mr. Cutler*

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|------------------------------------------------------------------------------------------------------------|---------------------|
| 405. INTERMEDIATE ECONOMIC THEORY (3)                                                                      | <i>Mr. Fouraker</i> |
| 412. ECONOMICS OF COLLECTIVE BARGAINING (3)                                                                | <i>Mr. Myers</i>    |
| 415. SOCIAL INSURANCE (3)                                                                                  | <i>Mr. Reede</i>    |
| 418. ECONOMICS OF WAGES AND EMPLOYMENT (3)                                                                 | <i>Mr. Newman</i>   |
| 419. CASE STUDIES IN LABOR-MANAGEMENT RELATIONS (3)                                                        | <i>Mr. Reede</i>    |
| 423. STATE AND LOCAL TAXATION (3)                                                                          | <i>Mr. Stout</i>    |
| 425. THE MONEY MARKET (3)                                                                                  | <i>Mr. McKinley</i> |
| 428. INCOME AND EMPLOYMENT THEORY (3)                                                                      | <i>Mr. Kautz</i>    |
| 429. FEDERAL FINANCES (3)                                                                                  |                     |
| 430. NATIONAL PLANNING (3)                                                                                 |                     |
| 431. HOUSING AND COMMUNITY DEVELOPMENT (3)                                                                 |                     |
| 433. INTERNATIONAL MONETARY ECONOMICS (3)                                                                  | <i>Mr. Mason</i>    |
| 434. INTERNATIONAL TRADE AND PUBLIC POLICY (3)                                                             | <i>Mr. Mares</i>    |
| 442. MONOPOLY, COMPETITION, AND THEIR REGULATION (3)                                                       | <i>Mr. Herman</i>   |
| 450. THE BUSINESS CYCLE (3)                                                                                |                     |
| 480. MATHEMATICAL ECONOMICS (3)                                                                            |                     |
| 490. MEASUREMENT OF THE ECONOMY (3)                                                                        | <i>Mr. Saylor</i>   |
| 499X. FOREIGN STUDY IN ECONOMICS (2-6)                                                                     |                     |
|                                                                                                            |                     |
| 500. ECONOMICS SEMINAR (3-6)                                                                               |                     |
| 501. RESEARCH METHODS IN ECONOMICS (3-6)                                                                   | <i>Mr. Cutler</i>   |
| 506. PROBLEMS IN ECONOMICS (3-6) Planned individual projects involving library, laboratory, or field work. |                     |
| 507. SEMINAR IN INTERNATIONAL ECONOMICS: THEORY AND POLICY (3-6)                                           |                     |
| 508. SEMINAR IN MONEY, CREDIT, AND PUBLIC FINANCE (3-6) Prerequisite: Econ. 51.                            |                     |
| 510. ECONOMETRICS (3) Statistical estimation in mathematically formulated economic relationships.          |                     |
| 511. SEMINAR IN INDUSTRIAL DISPUTES (3) Prerequisites: Econ. 14, 15.                                       | <i>Mr. Myers</i>    |
| 512. WAGES (3)                                                                                             |                     |
| 513. DEVELOPMENT OF ECONOMIC DOCTRINES (3-6) Prerequisite: Econ. 405.                                      | <i>Mr. Martin</i>   |
| 515. LABOR SEMINAR (3)                                                                                     | <i>Mr. Reede</i>    |
| 522. ADVANCED ECONOMIC THEORY (3-6) Theory of price and income determination. Prerequisite: Econ. 405.     |                     |

## EDUCATION

CHARLES M. LONG, *Head of the Department*  
109 Burrowes Building

Graduate degree programs in the department are provided for the advanced preparation of competent public school teachers, administrators, supervisors, and specialists. Candidates for the M.Ed., M.S., D.Ed., and Ph.D. degrees may major in business education, counseling in education, educational administration, elementary education, higher education (D.Ed. program only), clinical speech, and secondary education.



## EDUCATION

In general, admission requirements for the M.Ed. include 27 approved undergraduate credits in education and psychology including practice teaching in an area appropriate to the major, and aptitude for and interest in advanced professional preparation. Applicants are encouraged to have had at least two years of successful teaching experience. The admission requirements for the M.S. and Ph.D. degrees, and the D.Ed. degree in higher education, are slightly different.

Course sequences are also provided in audio-visual instruction, language arts education, history and philosophy of education, special education, educational research, curriculum and supervision, nature education, adult education, and safety education.

While candidates are required to specialize in a field of professional education, they are also encouraged to acquire a general education in the social sciences, the behavioral sciences, and the humanistic foundations.

In addition to these programs sponsored by the Department of Education, other departments offer work in agricultural education, art education, home economics education, industrial education, music education, physical education, and recreation education. Programs in these major fields are described elsewhere in this bulletin.

The M.Ed. degree is, in general, available in those fields outside of education for which a master's degree has been approved, provided such a professional program is appropriate. Thus, for example, the M.Ed. degree may be earned with a major in English or chemistry. These programs require an approved minor in education.

### EDUCATION (ED)

408. INTRODUCTION TO VOCATIONAL REHABILITATION (3)  
412. HISTORY OF MODERN EUROPEAN EDUCATION (3)  
413, 413X. HISTORY OF EDUCATION IN THE UNITED STATES (2-3)  
415, 415X. MODERN TENDENCIES IN AMERICAN EDUCATION (1-6)  
416X. SOCIAL EDUCATION (3)  
421X. MODERN TENDENCIES IN EDUCATIONAL METHOD (2-3)  
424, 424X. VISUAL AND OTHER SENSORY AIDS FOR TEACHERS (1-3)  
425, 425X. THE SCIENTIFIC DIRECTION OF LEARNING ACTIVITIES (2-4)  
426, 426X. EDUCATION OF EXCEPTIONAL CHILDREN (2-3) *Miss Neuber*  
427. EDUCATION OF THE MENTALLY RETARDED (2-3) *Miss Neuber*  
428, 428X. ADULT EDUCATION: ORGANIZATION, TYPES, AND METHODS (1-3) *Miss Cologne*  
*Unit A. History, Philosophy, and General Organization and Administration of Adult Education (1)*  
*Unit B. Types of Adult Education: Parental Education (1)*  
*Unit C. Methods in Adult Education and Leadership of Discussion Groups (1)*  
429, 429X. EDUCATION OF THE MENTALLY GIFTED CHILD (1-3) *Miss Neuber*  
430, 430X. VISUAL AND OTHER AIDS IN SAFETY EDUCATION (3)  
432b, 432bX. THE ELEMENTARY SCHOOL READING PROGRAM (2-3) *Messrs. Murphy and Hunt*  
432c, 432cX. READING PROBLEMS IN THE SECONDARY SCHOOL (2-3) *Messrs. Murphy and Hunt*  
432d, 432dX. SPECIAL PROBLEMS IN THE TEACHING OF ELEMENTARY SCHOOL ENGLISH (2-3) *Mr. Murphy*  
432eX. CHORAL SPEAKING (3) *Mr. Murphy*  
432f, 432fX. TEACHING SECONDARY SCHOOL ENGLISH (2-3) *Mr. Murphy*  
432g, 432gX. READING DISABILITIES (2-3) *Mr. Hunt*  
432h, 432hX. TECHNIQUES IN REMEDIAL READING (2-6) *Mr. Hunt*  
433e. ADVANCED THEORY OF KINDERGARTEN (3) *Mrs. Graffius*

- 433f, 433fX. TEACHING CHILDREN'S LITERATURE (2-3) *Mr. Murphy*  
 433h, 433hX. PROBLEMS OF ELEMENTARY SCHOOL ARITHMETIC (2-3) *Messrs. Corle and Russell*  
 433n, 433nX. TEACHING SOCIAL STUDIES IN THE ELEMENTARY GRADES (2-3) *Miss Taylor*  
 433w, 433wX. TEACHING SOCIAL STUDIES IN THE HIGH SCHOOL (2-3)  
 433y, 433yX. TEACHING MATHEMATICS IN THE SECONDARY SCHOOL (3)  
 435X. EDUCATION FOR CITIZENSHIP (2-3)  
 438, 438X. TEACHING SCIENCE IN SECONDARY SCHOOLS (2-3) *Miss Alfke*  
 438e, 438eX. TEACHING SCIENCE IN THE ELEMENTARY SCHOOL (1-3)  
 439, 439X. TEACHING TRAFFIC SAFETY AND AUTOMOBILE OPERATION (3) *Messrs. Neyhart and Intorre*  
 440, 440X. ORGANIZATION AND SUPERVISION IN SAFETY EDUCATION (3)  
 441X. PSYCHOLOGY OF ELEMENTARY SCHOOL SUBJECTS (2-3)  
 442, 442X. ELEMENTARY EDUCATION (2-3)  
 445. PRODUCTION OF VISUAL AND AUDITORY MEDIA (2-9)  
   *Unit A. Preparation of Educational Still Pictures (2-3)*  
   *Unit B. Scripting and Shooting Educational Motion Pictures (2-3)*  
   *Unit C. Editing and Sound Recording in the Production of Educational Motion Pictures (2-3)*  
 446, 446X. EDUCATIONAL TESTING PROGRAMS (3)  
 448X. ORGANIZATION OF THE ELEMENTARY SCHOOL CURRICULUM (2-3)  
 449a. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE ELEMENTARY SCHOOL (3)  
 449b. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE ELEMENTARY SCHOOL (3)  
 449c. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE SECONDARY SCHOOL (3)  
 449d. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE SECONDARY SCHOOL (3)  
 450X. SECONDARY EDUCATION (2-3) *Mr. Butler*  
 451X. SPECIAL PROBLEMS OF THE HIGH SCHOOL TEACHER (2-3)  
 453, 453X. GUIDANCE PRINCIPLES AND PRACTICES (3) *Mr. Wellington*  
 454, 454X. EXTRACURRICULAR ACTIVITIES IN THE JUNIOR AND SENIOR HIGH SCHOOL (2-3) *Messrs. Moyer and Patrick*  
 456, 456X. PRINCIPLES AND PROBLEMS IN BUSINESS EDUCATION (1-3) *Mr. Gemmell, Miss Veon*  
 459, 459X. IMPROVEMENT OF INSTRUCTION IN BUSINESS SKILL SUBJECTS (1-3) *Mr. Gemmell*  
 460. CURRICULUMS IN BUSINESS EDUCATION (3) *Mr. Gemmell*  
 461. IMPROVEMENT OF INSTRUCTION IN BASIC BUSINESS SUBJECTS (3) *Mr. Gemmell*  
 462. TEACHING OF SHORTHAND AND TYPEWRITING (3) *Mr. Gemmell*  
 463. TEACHING OF BOOKKEEPING (3) *Mr. Gemmell, Miss Veon*  
 464. METHODS OF TEACHING DISTRIBUTIVE EDUCATION (3)  
 466. TEACHING OF OFFICE PRACTICE (3) *Miss Veon*  
 467. TEACHING OF SHORTHAND (2-3) *Miss Veon*  
 468. TEACHING OF TYPEWRITING (2-3) *Miss Veon*  
 470, 470X. EDUCATIONAL STATISTICS AND MEASUREMENTS (2-3)  
 472. MEASUREMENT OF ACHIEVEMENT IN THE SECONDARY SCHOOL (2-3)  
 474, 474X. TEACHING AND GROUP GUIDANCE ABOUT OCCUPATIONS (3) *Mr. Corle*  
 475. MEASUREMENT OF ACHIEVEMENT IN THE ELEMENTARY SCHOOL (2-3)  
 480, 480X. EDUCATIONAL ADMINISTRATION (2-3) *Mr. DeLacy*



## EDUCATION

- 482X. SUPERVISION AND IMPROVEMENT OF INSTRUCTION (2-3)  
 485X. CURRICULUM CONSTRUCTION (2-3) *Messrs. McGarey and McNerney*  
 487, 487X. PROBLEMS IN VISUAL AND OTHER SENSORY AIDS IN EDUCATION (1-14)  
     *Unit A. Organization and Administration of Visual-Sensory Aids Programs (1-3)*  
     *Unit B. Motion Pictures in Education (2-3)*  
     *Unit C. Radio and Television in Education (3)*  
     *Unit D. Still Pictures (1-2)*  
     \**Unit E. Advanced Audio-Visual Equipment (3)*  
 490, 490X. PHILOSOPHIC BASIS OF EDUCATION (3)  
 491X. SCHOOL LAW (3)  
 493. CHARACTER EDUCATION (2-3) *Mr. Chiappetta*  
 494. RELIGIOUS EDUCATION (2-3)  
 497, 497X. WORKSHOP IN SELECTED STUDIES IN ELEMENTARY AND SECONDARY EDUCATION (1-6)  
 498, 498X. PRACTICUM IN THE EDUCATION OF ATYPICAL CHILDREN (1-8)  
 499, 499X. ATYPICAL CHILDREN AND EDUCATIONAL ADJUSTMENTS (3) *Miss Neuber*
501. INTRODUCTION TO THE ADVANCED STUDY OF EDUCATION (1-3) Methods of educational research; criticism of studies and theses in education; initiating research projects; summarizing results of research. Prerequisite: Ed. 470 or Psy. 415.  
*Mr. Davison*
502. SUPERVISED EXPERIENCE IN STUDENT COUNSELING (3) Practice in the application of guidance principles and methods to cases counseled under supervision; case conferences; seminar in guidance techniques. Prerequisite: Ed. 453.  
*Mr. Wellington*
503. SUPERVISION OF GUIDANCE WORKERS (3) Practical experience in supervising and evaluating work of counselors. Prerequisite: Ed. 502. *Mr. Wellington*
504. ORGANIZATION AND ADMINISTRATION OF GUIDANCE PROGRAMS (3) Principles, organization, personnel, functions, integration with school program, evaluation. Prerequisite: Ed. 453. *Mr. Wellington*
505. OCCUPATIONAL AND EDUCATIONAL INFORMATION (3) Occupational information for guidance purposes, educational information related to vocational choice and preparation. Prerequisite: Ed. 453. *Mr. Wellington*
506. STUDENT ANALYSIS PROCEDURES FOR COUNSELORS (3) Collection and use of data basic to the counselor's understanding of individuals; the counseling interview and techniques other than testing. *Mr. Wellington*
- 507, 507X. GUIDANCE SERVICES IN ELEMENTARY EDUCATION (3) Guidance services to elementary school students; guidance opportunities for elementary teachers and principals.
509. CONTRIBUTIONS OF PROFESSIONAL PERSONNEL TO VOCATIONAL REHABILITATION (3) Contributions of medical, social, psychological, and other specialists through the team approach; professional ethics, medical problems. Prerequisites: Ed. 408, 453.
510. INTERNSHIP IN PROFESSIONAL EDUCATION (1-9) Internship to take place in schools or educational situations where not regularly employed under supervision of graduate faculty.  
     *Unit A. Administration and Supervision (1-6)*  
     *Unit B. College Teaching (3-6)*

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\* This unit is not approved for extension.



- Unit C. Public School Research (3-6)*
- Unit D. Elementary Teaching (3-6)*
- Unit E. Secondary Teaching (3-6)*
- Unit F. Art Teaching and Supervision (3-6)*
- Unit G. Business Education Supervision (3-6)*
- Unit H. Special Education Supervision (3-6)*
- Unit I. Audio-Visual Education (3-6)*

511. SUPERVISED PRACTICUM IN REHABILITATION COUNSELING (1-6) Application of principles and techniques of rehabilitation counseling to cases involving handicapped individuals. Prerequisites: Ed. 408, 453.
512. PROFESSIONAL EXPERIENCE IN REHABILITATION COUNSELING (1-6) Supervised internship with responsibility for a regular case load. Prerequisite: Ed. 511.
515. COMPARATIVE EUROPEAN EDUCATION (3) Educational policies and practices in school systems in western and central European nations. Prerequisite: Psy. 14.  
*Messrs. Chiappetta and Russell*
516. SOCIAL FOUNDATIONS OF EDUCATION (2-4) Social institutions and functions and their relationship to public education; an analysis of the functions assignable to formal education. Prerequisites: Ed. 25, Psy. 14.  
*Mr. McNerney*
517. EVOLUTION OF EDUCATIONAL THOUGHT (2-3) Rise of formal educational philosophy from Plato to John Dewey; preliminary reference to Chinese, Hindu, Chaldean, Persian, Hebrew, and Egyptian theories.
523. LABORATORY IN ORGANIZATIONAL ASPECTS OF MATERIALS OF INSTRUCTION (1-3) Organizing, storing, circulating, and maintaining instructional material in an instructional materials library. Prerequisites: Ed. 424, 585. Conference 1 hour, alternate weeks by appointment.
524. SEMINAR IN CURRICULUM MATERIALS AND THEIR UTILIZATION (3) Advanced detailed analysis of mass communication media; relationships among these and educational objectives, individual differences in learners, and ideas to be communicated. Prerequisites: Ed. 424, 585, 6 credits in educational psychology.
525. MODERN TENDENCIES IN EDUCATIONAL METHOD (2-3) Study of science supporting dynamic instruction; principles of teaching as guides; analysis of modern procedures; understanding of learning; substance versus plans. Prerequisite: 12 credits of undergraduate work in education.  
*Messrs. Butler and Russell*
527. PROBLEMS IN THE EDUCATION OF THE MENTALLY RETARDED (1-4) Study of existing curriculums, instructional practices, educational programs; experimentation in curriculum building and materials construction. Prerequisites: Ed. 426 or 583, Unit P, and Ed. 427 and teaching experience.  
*Miss Neuber*
529. PROBLEMS IN THE EDUCATION OF THE MENTALLY GIFTED (1-4) Analysis of educational needs of mentally gifted; curriculum construction and curricular materials. Prerequisites: teaching experience and Ed. 426 or 583, Unit P, and 429.  
*Miss Neuber*
532. SUPERVISION OF STUDENT TEACHERS (3) A course in supervision for master teachers, department heads, and college teachers with supervisory responsibilities in teacher education. Prerequisite: teaching experience and 18 credits in education, including at least 5 in methods.  
*Mr. Moyer, Miss Taylor*

## EDUCATION

- 534a. **READING CLINIC PRACTICE: ANALYSIS OF READING DISABILITIES (1-9)** A laboratory course consisting of analysis of extreme reading disabilities and recommended remedial procedures; experience in preparation of case reports. Prerequisite: Ed. 432g or Psy. 550. *Mr. Hunt*
- 534b. **READING CLINIC PRACTICE: REMEDIAL PROCEDURES (1-9)** Practicum in special classes for reading disabilities; corrective and remedial procedures; specific procedures for correction of various types of reading disabilities. Prerequisite: Ed. 432g or 534a. *Mr. Hunt*
535. **SEMINAR ON READING INSTRUCTION (2-12)** Designed to appraise significant researches and to outline procedures and materials for research; reading readiness, word perception, basic reading skills, vocabulary development. Prerequisite: Ed. 432b or 432c. *Mr. Murphy*
536. **READING CLINIC RESEARCH (1-15)** Prerequisites: Ed. 432b; or Ed. 432c, 432g. *Mr. Murphy*
537. (Bot. 537, Zool. 537). **WORKSHOP IN THE BIOLOGICAL SCIENCES (3)** Projects designed for teachers of biology in the secondary schools.
540. **PROBLEMS OF ELEMENTARY EDUCATION (2-3)** Problems seminar for experienced educators. Prerequisite: 12 credits in education and psychology, including 6 in elementary education.
541. **SEMINAR IN CONTEMPORARY ISSUES IN ELEMENTARY EDUCATION (1-3)** Conferences and discussions designed to meet the needs of experienced teachers and principals in the field of elementary education. Prerequisite: 6 credits in elementary education and teaching experience.
546. **ELEMENTARY SCHOOL PRINCIPAL AS SUPERVISOR (2-3)**
548. **ORGANIZATION OF THE ELEMENTARY SCHOOL CURRICULUM (2-3)** Principles underlying curriculum construction. Primarily for elementary education majors. Prerequisite: Ed. 31 or teaching experience.
550. **PROBLEMS IN MODERN SECONDARY EDUCATION (1-4)** Historical, psychological, social, and economic factors influencing secondary education; required as basic course of all graduate students in secondary education. Prerequisite: secondary school teaching. *Mr. Butler*
551. **SEMINAR IN CONTEMPORARY ISSUES IN SECONDARY EDUCATION (2-9)**
- Unit A. The Secondary School Curriculum (2-3)* Principles and philosophy of curriculum construction. Each student works out an individual problem in the secondary school curriculum. Prerequisites: 12 credits in education and psychology, and teaching experience. *Mr. McNerney*
- Unit B. Laboratory Studies in Application of Educational Method (2-3)* Analysis and application of outstanding studies in secondary education; integration of results of educational research with public school procedures. Prerequisites: 12 credits in education and psychology, and teaching experience.
- Unit C. Organization and Administration of Secondary Education (2-3)* Problems in reorganization of secondary education, with particular reference to philosophy, organization, and teaching problems of the junior high school. Prerequisites: 12 credits in education and psychology and teaching experience. *Mr. Remaley*



556. THE SECONDARY SCHOOL PRINCIPAL AS SUPERVISOR (2-3) Improvement of instruction; improvement of teachers in service; evaluation of teaching procedures; methods of supervision; selection and use of textbooks. Prerequisite: three years' teaching experience. *Mr. McGarey*
561. THE COMMUNITY COLLEGE AND POST-SECONDARY SCHOOL EDUCATION (2-3) Philosophy, organization, and character of school programs needed to meet educational needs of individuals who desire to continue their education on the post-secondary school level. Prerequisites: Ed. 480, 550; Psy. 414 or educational experience. *Messrs. Patrick and Brown*
562. THE INSTRUCTIONAL PROGRAM IN COMMUNITY COLLEGES AND POST-SECONDARY EDUCATION (2-3) Course offerings, curriculums, instructional materials and procedures, guidance, extracurricular activities, student personnel, evaluation of results, and faculty qualifications. Prerequisites: Ed. 480, 550; Psy. 414 or educational experience.
563. THE PROFESSIONAL EDUCATION OF TEACHERS (3) Development and present status of teacher education; objectives and standards; selection and guidance of students; personnel problems in relation to staff. Prerequisite: 6 credits in advanced courses in education and a course in educational psychology. *Mr. Patrick*
564. RECENT TRENDS IN HIGHER EDUCATION (2-3) Factors affecting current college enrollment, organization, administration, support, and curriculums, with special emphasis on general education, its development, aims, and forms. *Mr. Brown*
565. THE PRINCIPLES OF COLLEGE TEACHING (2-3) Principles involved in teaching at the college level; effective use of teaching aids; criteria used in evaluation. *Mr. Brown*
566. STUDENT PERSONNEL PROGRAMS AT THE COLLEGE LEVEL (2-3) Student personnel services in higher education; organization of student advisory programs; use of personnel data; co-curricular activities; student welfare. *Mr. Wellington*
567. GROWTH AND ORGANIZATION OF HIGHER EDUCATION (2-3) Growth of higher education; influence of church, state, federal government; educational, social, and economic factors that have affected curriculums and organization of institutions. *Mr. Brown*
568. CURRICULUMS IN HIGHER EDUCATION (2-3) Various types of curriculums and philosophies underlying them; ways in which curriculums are developed; elective versus required courses; evaluation of achievement. *Mr. Brown*
569. SEMINAR IN COLLEGIATE EDUCATION (1-6) Special topics in higher education. Prerequisite: Ed. 567. *Mr. Weaver*
574. ADVANCED EDUCATIONAL STATISTICS (2-4) Appropriate measures and devices for experimental research in education including correlation measures, curve fitting, and analysis of variance. Prerequisite: 12 credits of graduate work in education including Ed. 470 or Psy. 415. *Mr. Davison*
575. ADMINISTRATION AND SUPERVISION IN BUSINESS EDUCATION (3) Work of administrators, supervisors, and others responsible for improvement of instruction in business education; use of vocational testing; job analysis. Prerequisite: 6 credits in secondary education. *Mr. Gemmell, Miss Veon*
576. INTRODUCTION TO RESEARCH IN BUSINESS EDUCATION (3) Methods of research in business education; opportunity to compile annotated bibliographies on current problems; analysis and evaluation of significant research. *Mr. Gemmell*



## EDUCATION

577. EVALUATION OF RESEARCH AND EMPIRICAL LITERATURE IN BUSINESS EDUCATION (3) Application of evaluation methods to current literature in business education; special attention to research studies. Prerequisite: Ed. 576. *Mr. Gemmell*
578. SEMINAR IN BUSINESS EDUCATION (1-6) Intended for graduate students preparing theses or final documents, or for those working on special studies in business education. Prerequisite: Ed. 577. *Mr. Gemmell*
580. SEMINAR IN SCHOOL ADMINISTRATION (1-6) Efficiency in supervision, methods of diagnosis and evaluation of teaching and learning procedure, improving instruction, maintaining teacher morale, stimulating co-operative work. Prerequisites: Ed. 480, 6 credits of Ed. 583.
582. EDUCATIONAL SURVEY TECHNIQUES (2-3) Methods for appraisal of an educational program; planning for expansion, consolidation, or reduction of educational offerings. Prerequisites: Ed. 480, 6 credits of Ed. 583.
- 583, 583X. PROBLEMS IN ADMINISTRATION AND SUPERVISION (2-27) Prerequisite: Ed. 480 or teaching or administrative or supervisory experience.
- Unit A. The Educational Plant (2-3)*
  - Unit B. Public Relations for School Administrators (2-3)*
  - Unit C. Public School Finance (2-3)*
  - Unit F. State and National Education Programs (2-3)*
  - Unit I. Administration of Adult Education in the Public Schools (3)*
  - Unit M. Legal Aspects of School Administration (3)*
  - Unit P. The Administration of Public School Education for Atypical Children (2-3)*
  - \*Unit Q. Dynamic Factors in School Administration (2-3)*
  - \*Unit R. Public School Business Administration (2-3)*
585. CURRICULUM CONSTRUCTION (2-3) Functions of administrators, supervisors, teachers, pupils, and laymen in curriculum building to meet pupil and community needs. *Mr. McGarey*
586. PRINCIPLES OF SCHOOL SUPERVISION (2-3) Organization of supervision; planning the supervisory program; developing standards of teaching and learning; improvement of learning through tests and teacher rating. Prerequisites: 18 credits in education and 3 years' teaching experience. *Mr. McNerney*
587. THE SECONDARY SCHOOL PRINCIPAL AS ADMINISTRATOR (2-4) Problems of schedule making, teachers' meetings, curriculum making and revision, organization of extracurricular and guidance programs. Prerequisite: teaching experience.
589. THE ELEMENTARY SCHOOL PRINCIPAL AS ADMINISTRATOR (2-3) Duties of the elementary school principal in organizing and administering his school. Prerequisite: Ed. 442.
590. ADVANCED PHILOSOPHY OF EDUCATION (2-4) Analysis of educational policy and practice for philosophic consistency and commitment; philosophical implication in selected educational literature. *Mr. Chiappetta*
591. EDUCATION IN RUSSIA, ASIA, AND THE MIDDLE EAST (2-3) Current educational activities in Soviet Russia and other eastern European countries; the Middle East, North Africa, and the Far East. *Mr. Chiappetta*

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\* These two units are not approved for extension.

592. EDUCATION IN THE LATIN-AMERICAN COUNTRIES (2-3) Recent educational progress in Central and South America, with special reference to Mexico, Cuba, Puerto Rico, Brazil, Chile, and Argentina.
594. SEMINAR IN EDUCATION (1-3) Conferences and discussions designed to meet the need for special study of particular fields in education. Prerequisite: 12 credits of graduate work in education. *Messrs. Long, Davison, and Russell*
597. WORKSHOP IN CURRENT EDUCATIONAL PROBLEMS (1-6) For administrators, supervisors, experienced elementary and secondary teachers, guidance workers; administrative, supervisory, and instructional problems involved in an emerging educational program. Prerequisite: 12 credits of graduate work in education.

## ELECTRICAL ENGINEERING

ARTHUR H. WAYNICK, *Head of the Department*  
105 Electrical Engineering Building

Graduate work leading to the M.S. and Ph.D. degrees is offered. Course offerings and research facilities are available in the following areas: information theory, microwave theory and techniques, networks, computers (including digital, analog, and network analyzer), control, power conversion, servomechanisms, tubes and transistors, dynamical machine analysis, power dispatching, relay protection, and wave propagation.

The entering student must hold the B.S. degree in engineering or science and have satisfactorily completed undergraduate course work in electrical circuits, machinery, and electronics.

### ELECTRICAL ENGINEERING (E E)

415. ILLUMINATION (3)
- 421a,b,c,d. ELECTRICAL ENGINEERING PROBLEMS (2-12)
422. CREATIVE ELECTRICAL ENGINEERING (3)
423. TRANSIENT PHENOMENA (3)
424. POWER FREQUENCY ELECTRONICS (3)
425. SYMMETRICAL COMPONENTS (3)
426. TRANSISTORS (3)
- 428, 428X. SERVOMECHANISMS (3)
432. ULTRA-HIGH-FREQUENCY TECHNIQUES (3)
- 435, 435X. ENGINEERING ANALYSIS (3)
436. DESIGN, CONSTRUCTION, AND TESTING OF VACUUM TUBES (3)
438. FUNDAMENTALS OF ELECTRIC WAVES (3)
439. PULSE TECHNIQUES (3)
- 440, 440X. VACUUM-TUBE CIRCUITS I (3)
- 441, 441X. VACUUM-TUBE CIRCUITS II (3)
- 450, 450X. ELECTRICAL NETWORK THEORY (3)
460. HIGH-VOLTAGE ENGINEERING (3)
461. FUNDAMENTALS OF POWER SYSTEM STABILITY (3)
470. ELECTRONIC ANALOG COMPUTERS (3)
471. LOGICAL DESIGN OF DIGITAL COMPUTERS (3)

## ELECTRICAL ENGINEERING

520. SEMINAR (1) Required of all graduate students in electrical engineering. Conferences, reading, and presentation of technical papers.
521. ADVANCED ELECTRICAL ENGINEERING PROBLEMS (2-12)
523. TRANSIENTS IN LINEAR SYSTEMS (3) Transient response of linear electric circuits and electromechanical systems including the application of operational methods of analysis to electrical and electromechanical problems. Prerequisite: E.E. 423.
524. ENGINEERING ELECTRONICS (3) Special problems dealing with design and application of electronic devices and systems; emphasis upon individual projects closely related to other phases of the student's graduate program.
525. SYMMETRICAL COMPONENTS (3) Polyphase circuits and machines under unbalanced conditions of operation including effects of rotating machines upon distribution and transmission system performance; characteristics of phase converters and single-phase operation of polyphase systems. Prerequisite: E.E. 425.
528. SERVOMECHANISMS (3) Advanced treatment of transient and steady-state behavior of closed-cycle control systems with special attention to stability and design of stabilizing controllers. Prerequisite: E.E. 428.
532. ULTRA-HIGH-FREQUENCY ENGINEERING (4) Theory of transmission lines, wave guides, resonant cavities, antennae, and wave propagation. Prerequisite: E.E. 432.
535. ENGINEERING ANALYSIS (3) Engineering applications of complex variables, conformal mapping methods and potential plotting. Laplace transform methods and stability criteria. Prerequisite: E.E. 435.
538. ELECTROMAGNETIC ENGINEERING (3) Electrical and magnetic fields, using the Maxwell-Lorentz equations as applied to vector fields and special solutions for antennae, wave guides, and other engineering applications. Prerequisite: E.E. 438.
550. COMMUNICATION NETWORKS (3) Methods of filter design using lattice networks; effects of dissipation on characteristics of filter networks; transient response of networks and design of equalizers. Prerequisite: E.E. 450.
570. ADVANCED ELECTRONIC ANALOG COMPUTERS (3) Theory and design of linear and nonlinear function generators for electronic analog computers; methods of synthesizing physical systems. Prerequisite: E.E. 470.
571. DIGITAL COMPUTATION AND CONTROL (3) Methods of analysis of digital computers; analysis of sampled-data systems for real-time control purposes.

## ENGINEERING MECHANICS

JOSEPH MARIN, *Head of the Department*  
204 Engineering A

The department offers graduate study programs leading to the M.S. and Ph.D. degrees. Research and graduate study are available in the following fields of engineering mechanics: dynamics and vibrations, theory of elasticity and strength of materials, experimental stress analysis, theory of plasticity and mechanical properties of materials. The department also offers a fluid mechanics option for both the M.S. and the Ph.D. degrees.



## ENGINEERING MECHANICS

In order to be admitted to graduate work in engineering mechanics, the student must have a B.S. degree in engineering or in some field of science. It is also necessary for him to have satisfactorily completed undergraduate courses in statics, dynamics, strength of materials, and materials of engineering.

### ENGINEERING MECHANICS (E MCH)

- 400, 400X. ADVANCED STRENGTH OF MATERIALS (3) *Mr. Hardenbergh*  
401, 401X. ELEMENTS OF VIBRATIONS (3) *Mr. Vierck*  
402, 402X. APPLIED AND EXPERIMENTAL STRESS ANALYSIS (3) *Mr. Oppel*  
403, 403X. MECHANICAL PROPERTIES OF MATERIALS AND DESIGN (3) *Mr. Marin*  
404, 404X. RESEARCH IN ENGINEERING MECHANICS (1-6)  
407, 407X. NUMERICAL METHODS OF ANALYSIS (3) *Mr. Vierck*  
408. ELASTICITY AND ENGINEERING APPLICATIONS (3) *Messrs. Hardenbergh and Hu*
500. ADVANCED MECHANICS OF MATERIALS (3-6) Strain energy methods; special problems in bending and torsion; curved bars, beams on elastic foundations; thick-walled cylinders, shrink-fit assemblies, and rotating discs; thin-walled pressure vessels; bending of thin plates; buckling of bars and plates. Prerequisite: E.Mch. 13. *Messrs. Marin and Oppel*
504. APPLIED ELASTICITY (3) Analyses of stress and strain in two dimensions; problems in elasticity and elastic stability; emphasis on applications to machine and structural design. Prerequisite: E.Mch. 13. *Mr. Oppel*
506. EXPERIMENTAL STRESS ANALYSIS (3) Experimental methods of stress determination including photoelasticity, stress coat and electric strain gauge techniques; stress analogies; strain rosettes for combined stress determinations. Prerequisite: E.Mch. 13. *Mr. Oppel*
507. THEORY OF ELASTICITY AND APPLICATIONS (3) Equations of equilibrium and compatibility; stresses and strains in beams, curved members, rotating discs, thick cylinders, torsion and structural members. Prerequisite: E.Mch. 13. *Messrs. Oppel and Arkilic*
508. THEORY OF ELASTIC STABILITY AND APPLICATIONS (3) Buckling of slender and short members; buckling of I-beams; stability of thin-walled constructions; thin-walled cylinders subjected to internal pressures; applications to structural parts including aircraft members. Prerequisites: E.Mch. 12, 13.
509. THEORY OF PLATES AND SHELLS (3) Bending of circular and rectangular plates; buckling of plates; plates on elastic foundations; deformation of shells without bending; applications to engineering problems. Prerequisite: E.Mch. 13. *Mr. Arkilic*
514. ENGINEERING MECHANICS SEMINAR (1 per semester) Current literature and special problems in engineering mechanics.
516. MATHEMATICAL THEORY OF ELASTICITY (3) Stress and strain dyadics; conditions for single valued displacement; incompatibility dyadic; generalized Hooke's Law; uniqueness theorem; special topics in elasticity. Prerequisites: Math. 417, 405. *Mr. Arkilic*
520. ADVANCED DYNAMICS (3) Dynamics of a particle and of rigid bodies; Newtonian equations in moving co-ordinate systems; Lagrange's and Hamilton's equa-

## ENGINEERING MECHANICS

tions of motion; special problems in vibrations and dynamics. Prerequisites: E.Mch. 12, Math. 44 or 431. *Mr. Davids*

522. **THEORY OF VIBRATIONS (3)** Mathematical theory of vibrating systems; damping phenomena; forced vibrations; analogy between mechanical and electrical vibrations; transverse and torsional oscillation of shafts; vibration of strings, beams, membranes, and plates. Prerequisites: E.Mch. 13, Math. 44 or 431.

*Mr. Vierck*

523. **RELAXATION METHODS (3)** Relaxation methods compared to iteration and other numerical methods of analysis; application to elasticity, plasticity, stability, fluid flow, heat transfer, and related fields. Prerequisites: E.Mch. 13 or 111, Math. 44.

*Mr. Vierck*

524. **MATHEMATICAL METHODS IN ENGINEERING (3-6)** Prerequisite: Math. 451 or E.E. 435 or M.E. 452.

*Mr. Davids*

*Unit A (3)* Matrix and tensor analysis, finite differences, relaxation, perturbation, and other approximate methods in solution of various engineering problems.

*Unit B (3)* Energy methods, potentials, application to torsion problems, non-linear problems, analogies and dimensional analysis, Bessel and other special functions, harmonic analysis.

526. **NONLINEAR MECHANICS (3)** Integral curves, singular points, self-sustained oscillations, stability problems, Hill's and Van der Pol's equation, mechanical and electrical applications. Prerequisite: E.Mch. 522.

528. **EXPERIMENTAL METHODS IN VIBRATIONS (3)** Investigation of one or more degrees of freedom, free and forced mechanical vibrations, vibration properties of materials, vibration techniques in nondestructive testing. Prerequisite: E.Mch. 401 or 522.

*Mr. Brennan*

529. **ENGINEERING APPLICATIONS OF SONICS (3)** Sound and ultrasound in engineering and science; principles, radiation, transducers, devices for sonic processing and testing. Prerequisite: Phys. 443.

530. **MECHANICAL PROPERTIES OF MATERIALS AND DESIGN (3)** True stress-strain relations in tension; plastic stress-strain equations for combined stresses; theories of failure for static and fatigue stresses; impact loads; creep of metals; applications to structural and machine design. Prerequisite: E.Mch. 14.

*Mr. Marin*

- 531a. **THEORY OF PLASTICITY AND APPLICATIONS A (3)** Yield conditions; theories of plasticity; differential equation methods; analogy methods; applications to bending, torsion, thick-walled cylinders and discs. Prerequisite: E.Mch. 504 or 507.

*Messrs. Hu and Marin*

- 531b. **THEORY OF PLASTICITY AND APPLICATIONS B (3)** Variational principles; limit design; slip line theory; shake down principle; anisotropic metals; application to structure design, metal processing, soil mechanics. Prerequisite: E.Mch. 531a.

*Mr. Hu*

533. **DETERMINATION OF MECHANICAL PROPERTIES (3)** Experimental methods for determining hardness, elastic constants, creep behavior, fatigue strength, plastic flow, and dynamic properties of metals. Prerequisite: E.Mch. 14 or 530.

*Mr. Hu*

534. **PHOTOELASTICITY (3)** Analysis of polariscopes; isoclinics, isochromatics, and stress trajectories; two- and three-dimensional photoelastic methods; determination of principal stresses; model preparation.

*Mr. Oppel*

540. MECHANICS OF CONTINUA (3) Unified mathematical treatment of elements of fluid mechanics and of elasticity and plasticity of solids. Prerequisite: Math. 44 or 431.

## ENGLISH

A. BRUCE SUTHERLAND, *Acting Head of the Department*  
204 Sparks Building

Graduate work in English leads to the M.A. and Ph.D. degrees. The student may specialize in English literature, American literature, philology, or rhetoric. It is preferred that an entering student present 24 credits in English, but 18 credits in English exclusive of survey and freshman courses will be accepted. If the student does not present 18 credits in English, he must make up the deficiency early in his graduate work.

## ENGLISH COMPOSITION (E CMP)

- |                                                |                     |
|------------------------------------------------|---------------------|
| 404. PUBLIC OPINION AND WRITTEN PERSUASION (3) | <i>Mr. Graves</i>   |
| 408. ENGLISH GRAMMAR (3)                       | <i>Miss McElwee</i> |
| 418. THE WRITING OF LITERARY CRITICISM (3)     | <i>Mr. Bressler</i> |
| 442. CONTEMPORARY PROSE STYLE (3)              | <i>Mr. Major</i>    |

## ENGLISH LITERATURE (E LIT)

- |                                                    |                       |
|----------------------------------------------------|-----------------------|
| 400. TEACHERS' COURSE IN LITERATURE (3)            |                       |
| 401. MAIN CURRENTS IN AMERICAN LITERATURE (3)      | <i>Mr. Sutherland</i> |
| 423. FORMS AND MOVEMENTS OF BRITISH LITERATURE (3) | <i>Mr. Ridenour</i>   |
| 439. OUR CONTEMPORARIES (3)                        |                       |
| 440. MASTERS OF BRITISH LITERATURE (3)             |                       |
| 441. MASTERS OF AMERICAN LITERATURE (3)            |                       |
| 460. LITERARY BIOGRAPHY (3)                        |                       |
| 464. SPENSER (3)                                   | <i>Miss Locklin</i>   |
| 466. MILTON (3)                                    | <i>Mr. Condee</i>     |
| 480. THE DRAMA BEFORE SHAKESPEARE (3)              |                       |
| 481. JACOBAN AND CAROLINE DRAMA (3)                | <i>Mr. Harris</i>     |
| 484. AMERICAN DRAMA (3)                            | <i>Mr. Rubin</i>      |
| 486. LATER BRITISH AND IRISH DRAMATISTS (3)        |                       |
| 487. MODERN CONTINENTAL DRAMA (3)                  |                       |
| 488. THE DRAMA FROM DRYDEN TO SHERIDAN (3)         | <i>Mr. Harris</i>     |

## ENGLISH (ENGL)

501. MATERIALS AND METHODS OF RESEARCH (3) Bibliography of literary history and criticism; methods of editing and annotating texts; form and materials of dissertations. Required of all graduate students with an English major.  
*Mr. Ridenour*
502. CLASSICAL ORIGINS OF ENGLISH PROSE AND POETIC THEORIES (3) Rhetorical and poetic doctrine of ancient and medieval times.  
*Mr. Reed*



507. RESEARCH PROBLEMS IN ENGLISH (1-6) Methods of research in English, problems of bibliography, and method of evaluating sources and materials.
508. BEOWULF (3) Reading of the text and study of the prominent literary problems and relationships.
509. NONDRAMATIC WRITERS OF THE ELIZABETHAN PERIOD: THE PROSE WRITERS (3)
510. NONDRAMATIC WRITERS OF THE ELIZABETHAN PERIOD: THE POETS (3) *Miss Locklin*
514. SHAKESPEARE (3) Special problems in the works of Shakespeare. *Mr. Bowman*
515. THE AGE OF SWIFT (3) Special studies varying from year to year. *Mr. Harris*
516. THE AGE OF JOHNSON (3) The work of Johnson and his circle. *Mr. Mead*
517. BYRON, SHELLEY, AND KEATS (3) *Mr. Ridenour*
518. PRE-ROMANTIC WRITERS (3) Development of Romantic ideas in the 18th century. *Mr. Ridenour*
519. WORDSWORTH, COLERIDGE, SOUTHEY, AND SCOTT (3) *Mr. Ridenour*
530. HISTORY OF THE ENGLISH LANGUAGE (3) Germanic background of English, phonological and morphological developments, dialect differentiations, and principles of linguistic change. *Mr. Mead*
531. OLD ENGLISH (3) Old English language and literature with lectures on Old English and Germanic philology.
532. MIDDLE ENGLISH (3) Middle English language and literature with lectures on the development of Old English through Middle English to modern times. *Mr. Mead*
534. HISTORICAL ENGLISH GRAMMAR (3) Evolution of the grammatical system of English. *Mr. Peck*
535. RENAISSANCE AND MODERN RHETORIC (3) The rhetorical and poetic doctrine of Renaissance and modern times. *Mr. Bressler*
540. CHAUCER (3) Analysis of Chaucer's poetry in the light of its background, sources, and subsequent influences. *Mr. Mead*
542. PROSE STYLE (3) Development of English prose style. *Mr. Major*
543. CAVALIER AND ANGLICAN (3) Poetry and prose of the middle years of the 17th century from the death of Shakespeare to 1660.
544. RESTORATION LITERATURE (3) Selected studies of writers in England between 1650 and 1700. *Mr. Harris*
545. POETS OF THE VICTORIAN PERIOD, EXCLUSIVE OF TENNYSON AND BROWNING (3)
546. TENNYSON AND BROWNING (3)
547. PROSE WRITERS OF THE VICTORIAN PERIOD (3)
550. SELECTED STUDIES IN THE BRITISH NOVEL TO 1840 (3) *Mr. Bowman*
551. SELECTED STUDIES IN THE BRITISH NOVEL FROM 1840 TO THE PRESENT (3) *Mr. Sutherland*

562. THE AMERICAN NOVEL (3) *Mr. Werner*
563. AMERICAN ESSAYS (3) Lectures and reports on a special group of essayists. *Mr. Werner*
565. THE AMERICAN SHORT STORY (3) *Mr. Werner*
566. AMERICAN POETRY (3) *Mr. Werner*
567. ANGLO-AMERICAN FOLK SONG (3) Oral tradition of melodies and texts; types, regions, theories. *Mr. Bayard*

## ENTOMOLOGY

BERTIL G. ANDERSON

*Head of the Department of Zoology and Entomology*  
212 Frear Laboratory

Work leading to the M.S. degree with a major in entomology is offered with specialization in apiculture, ecology, economic entomology, morphology, physiology, insect resistances of plants, taxonomy, or toxicology of insecticides.

In order to undertake graduate work in this field, a student is required to have had 24 credits in entomology or zoology and related biological sciences; and he should have had chemistry through organic chemistry. Courses in physics and mathematics are also advantageous. A limited deficiency may be made up, without degree credit, while pursuing graduate work.

### ENTOMOLOGY (ENT)

401. MEDICAL AND VETERINARY ENTOMOLOGY (3) *Mr. Frings*
403. SYSTEMATIC ENTOMOLOGY (3) *Mr. Rutschky*
405. INSECT MORPHOLOGY (3) *Mr. Rutschky*
407. INSECT ECOLOGY (3)
413. ENTOMOLOGY SEMINAR (1 per semester)
429. PRINCIPLES OF INSECT CONTROL (3) *Mr. Blackburn*
430. INSECT HISTOLOGY (2) *Mr. Rutschky*
431. ENTOMOLOGICAL PROBLEMS (1-6)
445. THE IDENTIFICATION OF INSECTS (3)
505. ADVANCED MORPHOLOGY OF INSECTS (3) Advanced work in either external or internal morphology of insects. Prerequisites: Ent. 403, 405. *Mr. Rutschky*
506. IMMATURE INSECTS (3) The morphology and taxonomy of the immature stages of insects. Prerequisite: 9 credits in entomology. *Mr. Blackburn*
508. THE BIOLOGICAL CONTROL OF INSECTS (2) Artificial use of bacteria, fungous diseases, and animals in control of injurious insects; methods and equipment for rearing parasites and predators on a large scale. Prerequisites: Ent. 6, 8, 407.
509. ENTOMOLOGICAL TECHNIQUE (2) For advanced students dealing with special methods of collecting, rearing living insects, preparing and preserving immature stages, keeping records, and preparing illustrations for manuscript. Prerequisite: Ent. 6. *Mr. Coon*

## ENTOMOLOGY

514. ADVANCED SYSTEMATIC ENTOMOLOGY (1-15 per semester) Taxonomy of various orders of insects selected to meet the needs of the individual student. Prerequisites: Ent. 403, 405. *Mr. Rutschky*
528. INSECT PHYSIOLOGY (4) Normal functions of the insect body. *Mr. Smyth*
531. INSECT TOXICOLOGY (2) General principles of toxicology and survey of the actions of substances toxic to insects. *Mr. Smyth*
540. INSECT RESISTANCE IN PLANTS (2) Mechanism, expression, permanence, and measurement of resistance to insects with special reference to farm crops.

## FOODS AND NUTRITION

MIRIAM E. LOWENBERG, *Head of the Department*  
202A Home Economics Building

The M.S. and M.Ed. degrees are offered in foods or in nutrition. The Ph.D. and D.Ed. degrees are offered in the field of nutrition. The M.S. degree in nutrition in public health is offered in a co-operative program with the University of Pittsburgh.

The student may specialize in foods and nutrition to prepare for teaching in high school or for teaching and/or research work in college. She may also prepare for leadership in adult programs. Study at the master's degree level in foods also prepares students for work in commercial food research laboratories. The program in nutrition in public health prepares the student to work in a public health agency. In addition to receiving training in public health, she has the opportunity to further her preparation in foods and nutrition as well as in other areas dealing with families.

The minimum undergraduate preparation for graduate work in this area includes 18 semester hours in the physical and biological sciences (inorganic, organic, and biological chemistry; bacteriology; and physiology), 9 in the social sciences, and 10 in foods and nutrition.

### FOODS, NUTRITION, AND HEALTH (F N)

400. SPECIAL PROBLEMS IN FOODS AND NUTRITION (1-3)
420. EXPERIMENTAL COOKERY (1-6) *Miss Olson*
421. ADVANCED FOODS (3) *Miss Batjer*
- 423, 423X. (H.M.F.E. 423). FAMILY FOOD PURCHASING (2)
425. FOOD PRESERVATION (2) *Miss Hester*
426. RECENT DEVELOPMENTS IN FOODS (3)
450. NUTRITION (4) *Miss Padgett*
451. RECENT DEVELOPMENTS IN NUTRITION (3)
452. ELEMENTS OF DIET IN DISEASE (3) *Miss Pike*
- 455, 455X. TEACHING NUTRITION TO BOYS AND GIRLS (3)
456. NUTRITION IN THE COMMUNITY (3) *Miss Lowenberg*
- 491, 491v. TEACHING HOME NURSING (1)
520. READINGS IN FOODS (2) Critical review and reports of literature on selected food topics. *Miss Hester*
521. SEMINAR IN FOODS (1-6) Discussion and reports on current research in the foods field. Prerequisite or concurrent: F.N. 520. *Miss Hester*



## FOODS AND NUTRITION

522. ADVANCED EXPERIMENTAL FOODS (3) Experimental methods used in measuring the quality of foods; specific problems in food preparation. *Miss Hester*
530. PROBLEMS IN FOODS AND NUTRITION (1-6)
- 531, 531X. ADVANCES IN FOODS AND NUTRITION (3) Recent findings in the related areas of foods and nutrition.
550. READINGS IN NUTRITION (3) Readings and reports of selected topics in nutrition. Prerequisite: F.N. 450. *Miss Padgett*
551. SEMINAR IN NUTRITION (1-6) Selected topics and recent advances in nutrition.
552. DIET IN DISEASES (3) Physiological and biochemical problems in metabolic diseases and the nutritional aspects of therapy. *Miss Pike*
553. NUTRITION OF CHILDREN (3) Nutritional needs of the normal child during prenatal life, infancy, and childhood. Prerequisites: A.B.Ch. 35, F.N. 450. *Miss Padgett*
555. FIELD WORK IN NUTRITION (2-4) Field problems planned to meet the needs of individual students. Hours and problems to be arranged.
556. THE SURVEY METHOD IN FOODS AND NUTRITION (2) Study of survey technique as a tool in the assay of food adequacy and nutritional status. *Miss Dodds*
557. INTERRELATIONSHIPS OF NUTRIENTS (2) Interrelationships of nutrients in the metabolic processes; their significance as applied to nutrition. *Miss Pike*

## FORESTRY

WILLIAM C. BRAMBLE, *in Charge of Forestry Programs*  
102 Forestry Building

The School of Forestry offers graduate work leading to the M.S. and M.F. degrees with a major in forestry. In the Department of Forest Management a student may specialize in forest management, silviculture, or wildlife management; in the Department of Wood Utilization he may specialize in wood utilization, wood technology, or forest products.

A B.S. degree in forestry normally provides the minimum preparation for specialization in any of the above areas except wood utilization. A B.S. degree in wood utilization, or a similar program emphasizing mathematics and basic engineering courses, provides the minimum preparation for specialization in wood utilization and is acceptable for advanced work in wood technology and forest products. Preparation for graduate work in wildlife management may be secured in any program which has emphasized land management and has included work in dendrology, silvics, forest measurement, and forest management.

Students with limited deficiencies may be admitted but must make up deficiencies without degree credit.

### FORESTRY (FOR)

421. REGIONAL SILVICULTURE (4)  
427. FOREST RANGE MANAGEMENT (3)

*Mr. Cope*  
*Mr. Chisman*

## FORESTRY

445. IMPROVEMENTS (3)  
 450. ADVANCED MENSURATION (3)  
 455. AERIAL PHOTOGRAMMETRY IN FOREST MANAGEMENT (2)  
 466. FOREST MANAGEMENT AND MANAGEMENT PLANS (4)  
 468. SILVICULTURAL RESEARCH (3-6) *Mr. Chisman*  
 469. PROBLEMS IN FOREST MANAGEMENT (3)  
 475. PROBLEMS IN FOREST ECONOMICS AND FINANCE (3) *Mr. Humphrey*  
 480. POLICY AND ADMINISTRATION (3)  
 491. LOGGING AND LUMBERING (3) *Mr. Schmidt*  
 497. SMALL SAWMILLS (3) *Mr. Schmidt*
504. RESEARCH METHODS IN FORESTRY (2-6 per semester) Review of methods employed in conducting forestry research.
508. FOREST ECOLOGY (2-4) Organization, development, and classification of forest communities. *Mr. Bramble*
509. COVERT MANAGEMENT (2) Management of forest associations for maintenance and development of wildlife. Prerequisite: For. 508. *Mr. Bramble*
510. FORESTRY SEMINAR (1-2 per semester) Current problems of forest research presented as weekly seminar reports. May be repeated with additional credit for each semester's work.
550. FOREST MENSURATION (2-8 per semester) Research in some chosen field. Prerequisite: For. 450.
560. FOREST MANAGEMENT (3-8) Special topics in forest management and research in some chosen field. Prerequisite: For. 466.
575. APPLICATIONS OF FOREST ECONOMICS AND FINANCE (3 per semester) Survey of situations in forestry where business problems and particular circumstances of production, value, and costs are currently significant. Prerequisite: For. 70. *Mr. Humphrey*
590. THE LUMBER INDUSTRY (2-4) Relation of the lumber industry to national economy and world trade; lumbermen's associations; lumber accounts.
591. PROBLEMS IN LOGGING AND LUMBERING (2-6) Research in some chosen phase of lumbering. Prerequisite or concurrent: For. 590.

## WOOD UTILIZATION (W U)

404. MECHANICAL PROPERTIES OF WOOD (3) *Mr. Nearn*  
 405. VENEER AND PLYWOOD (3) *Messrs. Jorgensen and Nearn*  
 431. PROBLEMS IN FOREST PRODUCTS (3-6) *Messrs. Norton and Nearn*  
 435. SEASONING AND PRESERVATION (3) *Mr. Nearn*  
 437. ADVANCED WOOD TECHNOLOGY (3) *Messrs. White and Jorgensen*  
 462. DEFECTS IN WOOD (3) *Mr. Norton*  
 492. LUMBER DISTRIBUTION (3) *Mr. Schmidt*  
 495. MILLING AND COSTS IN THE FOREST PRODUCTS INDUSTRIES (3) *Mr. Schmidt*
502. WOOD FIBERS (3-5) Identification and physical and chemical characteristics of wood fibers used for pulp, either for paper or as a source of cellulose. Pulping quality, fiber measurements. *Mr. White*

510. WOOD UTILIZATION SEMINAR (1-2 per semester)
530. PROBLEMS IN WOOD UTILIZATION (3-6 per semester) Prerequisite: W.U. 431.  
*Mr. Norton*
531. STRUCTURAL USES OF WOOD AND WOOD PRODUCTS (3-6 per semester) Wood as a construction material; testing techniques for structural timbers and wood assemblies; use of laminated wood, ring connectors, and other types of special construction. Prerequisite: W.U. 404.  
*Mr. Norton*
532. LAMINATES (3-6 per semester) Advanced and special studies in fabrication and use of plywood, laminated wood, paper-base laminates, and wood-to-metal bonding. Prerequisite: W.U. 405.  
*Mr. Norton*
535. CONDITIONING TREATMENTS FOR WOOD (3-6 per semester) Advanced study and problems in preservative, seasoning, and other special treatments for wood and wood products. Prerequisite: W.U. 435.  
*Mr. Norton*

## FUEL TECHNOLOGY

PHILIP L. WALKER, JR., *Head of the Department*  
212 Mineral Industries Building

Graduate work in this department leads to the M.S. and Ph.D. degrees. The course program includes the chemistry and combustion of solid, liquid, and gaseous fuels. There is opportunity for research in the chemistry of coals and carbons and in the combustion of fuels.

A bachelor's degree with undergraduate training in one of the following fields is necessary for admission: chemistry, chemical engineering, physics, or fuel technology.

### FUEL TECHNOLOGY (F T)

400. FUEL TECHNOLOGY RESEARCH AND DESIGN (1-3)
401. FUEL GASES AND GASIFICATION (3) *Mr. Young*
402. CHEMICALS FROM FUELS (2) *Mr. Kinney*
404. FUEL TECHNOLOGY DESIGN (3) *Mr. Spicer*
405. COMBUSTION CALCULATIONS (3) *Mr. Young*
406. GASEOUS COMBUSTION (3) *Mr. Palmer*
408. COMBUSTION TECHNOLOGY (4) *Mr. Spicer*
- 409, 409X. THERMAL PROCESSING OF FUELS (2) *Mr. Polansky*
410. THERMAL PROCESSING LABORATORY (2) *Mr. Polansky*
503. CHEMICAL CONSTITUTION AND SCIENTIFIC CLASSIFICATION OF COAL (3-6) Chemistry of plant constituents in relation to coal and the coalification process; constitution of coal as deduced by chemical methods; scientific classification of coals. Prerequisite: Chem. 31. *Mr. Kinney*
505. PHYSICOCHEMICAL PROPERTIES OF COAL, MINERAL MATTER, AND ASH (3) Physical, physicochemical, and use properties; their significance and applications. Prerequisite: Chem. 461.
506. ADVANCED SOLIDS COMBUSTION (3) Current approaches to heterogeneous reactions in combustion and gasification of coals and carbons. Prerequisite: Chem. 461. *Mr. Walker*



## FUEL TECHNOLOGY

507. **ADVANCED THERMAL PROCESSING (3)** Pyrolysis, coal carbonization, coke manufacture and uses; action of heat on coals and fuels; technical and economic factors. Prerequisites: Chem. 35, 461, or Mn.Pr. 410. *Mr. Polansky*
508. **SYNTHESIS OF LIQUID FUELS (3)** Chemical nature of liquid hydrocarbons; preparation of hydrogen and synthesis gas; theoretical and practical aspects of synthetic liquid fuel processes. Prerequisites: Chem. 31, F.T. 402. *Mr. Kinney*
509. **TECHNOLOGY OF TARS (3)** Formation, constitution, physical and chemical properties of coal, oil-gas and water-gas tar; processing and utilization. Prerequisite: Chem. 31. *Mr. Polansky*
510. **FUEL TECHNOLOGY PROBLEM (1-6 per semester)** Special problems in fuel technology. Prerequisite: F.T. 503.
511. **FUEL TECHNOLOGY SEMINAR (1-6)** Selected topics from current fuel technology research examined and discussed. Prerequisite: Chem. 35 or 461. *Mr. Kinney and Staff*
512. **ADVANCED GASEOUS COMBUSTION (3)** Theories of reaction mechanisms; measurement of gaseous combustion parameters; review of current literature. Prerequisite: F.T. 406. *Mr. Palmer*

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in fuel technology studies are listed under Mineral Sciences in Part II of this bulletin.

## GENERAL HOME ECONOMICS

DOROTHY HOUGHTON, *Professor of Home Economics*  
103 Home Economics Building

General home economics is an unusual major not found in most graduate schools. It is planned for teachers in secondary schools or small colleges and others who wish to be proficient in several areas of home economics. Consequently, the student must have a strong home economics background for admission to the major.

The major for the M.S. or M.Ed. degree consists of a minimum of 6 credits in each of three areas of home economics. Three areas of home economics are also the basis for the major at the doctoral level (Ph.D. or D.Ed.). However, the minimum credit requirements in each area are established after consultation with a committee which reviews all previous work.

The student chooses a minor field of basic education or one of the applied fields, such as home economics education, secondary education, or higher education.

### GENERAL HOME ECONOMICS (G H E)

400, 400v, 400X, 400vX. **RECENT FINDINGS IN HOME ECONOMICS (2-3)**

516, 516v. **METHODS OF RESEARCH IN HOME ECONOMICS (3)** Review of problems and techniques of research in home economics. Required of all graduate students in home economics. *Miss Hatcher*

530. **SELECTED PROBLEMS IN GENERAL HOME ECONOMICS (1-6)**

## GENETICS AND BREEDING

JAMES E. WRIGHT, *Chairman of the Committee on Genetics and Breeding*  
307 Buckhout Laboratory

The M.S. and Ph.D. degrees are offered in the fields of theoretical and applied genetics. Courses in genetics and breeding are given by various departments. The basic and theoretical courses are listed as identical numbers in the Department of Botany and Plant Pathology and the Department of Zoology and Entomology. Courses dealing with genetic principles as applied to specific organisms are offered in the Departments of Agronomy, Animal Husbandry, Bacteriology, Horticulture, and Poultry Husbandry. The graduate committee for majors shall be appropriately represented by members of theoretical and applied phases who shall have the responsibility and jurisdiction for determining course work and research acceptable in satisfying degree requirements.

Minimum requirements for entry as a major in this field shall consist of not less than 15 credits in basic biology and 15 credits in the areas of chemistry, mathematics, and physics.

The following courses are available in genetics and breeding, and their descriptions may be found under the offerings of the several departments: Agro. 411, 509, 510, 582; A.H. 501, 505; Bact. 516; Bot. or Zool. 405, 422, 505, 524, 528, 533; Hort. 444, 503, 519, 520; P.H. 412.

## GEOGRAPHY

E. WILLARD MILLER, *Head of the Department*  
202 Mineral Sciences Building

The department offers graduate work leading to the M.S., M.Ed., Ph.D., and D.Ed. degrees. Students may concentrate on cartography, physical geography, human geography, political geography, economic geography, or regional geography.

In order to enter graduate work, a student must qualify under one of two possible options: Option 1 requires that a student have completed as an undergraduate, with satisfactory grades, 18 credits in geography and 20 credits in mathematics and biological or physical sciences, including at least 6 credits in geology. Option 2 requires 18 undergraduate credits in geography plus 20 credits in the social sciences including at least 3 in economics.

## GEOGRAPHY (GEOG)

400. REGIONAL GEOGRAPHY OF NORTH AMERICA (3)	Mr. Deasy
401. REGIONAL GEOGRAPHY OF PENNSYLVANIA (3)	Mr. Miller
403. REGIONAL GEOGRAPHY OF SOUTH AMERICA (3)	Mrs. Griess
405. GEOGRAPHY OF POPULATION AND SETTLEMENT (3)	Mr. Rodgers
420. URBAN GEOGRAPHY (3)	Mr. Rodgers
427. REGIONAL GEOGRAPHY OF THE SOVIET UNION (3)	Mr. Rodgers
433. REGIONAL CLIMATOLOGY (3)	Mr. Wernstedt
435. FIELD METHODS IN GEOGRAPHY (3)	Mr. Miller
442. GEOGRAPHY OF EUROPE (3)	Mr. Miller
443. GEOGRAPHY OF THE ORIENT (3)	Mr. Wernstedt

## GEOGRAPHY

444. GEOGRAPHY OF AFRICA (3) *Mrs. Griess*  
452. INTERPRETATION OF AERIAL PHOTOGRAPHS (3) *Mr. Deasy*  
460, 460X. POLITICAL GEOGRAPHY (3) *Mrs. Griess*  
480. GEOGRAPHY OF WORLD MANUFACTURING (3) *Mr. Miller*  
490. PHYSICAL GEOGRAPHY FOR TEACHERS (3)
503. ADVANCED REGIONAL GEOGRAPHY (3-12) Intensive study at an advanced level of selected regions or sections of the continents. Prerequisite: 12 credits in geography.
504. PHYSICAL GEOGRAPHY SEMINAR (3-12) The literature of some phase of physical geography with emphasis on procedures for organizing material for classroom reports and discussions.
505. ECONOMIC GEOGRAPHY SEMINAR (3-12) The literature of some phase of economic geography with emphasis on procedures for organizing material for classroom reports and discussions.
506. CULTURAL AND POLITICAL GEOGRAPHY SEMINAR (3-12) The literature of some phase of cultural and political geography with emphasis on procedures for organizing material for classroom reports and discussions.
507. DEVELOPMENT OF GEOGRAPHIC THOUGHT (1-6) Critical analysis of the growth of geographic thought from antiquity to the present; emphasis on structure of modern geography.
510. PHYSICAL GEOGRAPHY RESEARCH (3-10) Original study in physical geography: a field problem or detailed library investigation with analysis and presentation of data.
511. ECONOMIC GEOGRAPHY RESEARCH (3-10) Original study in economic geography: a field problem or detailed library investigation with analysis and presentation of data.
512. CULTURAL AND POLITICAL GEOGRAPHY RESEARCH (3-10) Original study in cultural and political geography: a field problem or detailed library investigation with analysis and presentation of data.

## GEOLOGY

FRANK M. SWARTZ, *Head of the Department*  
110 Mineral Sciences Building

Graduate work leading to the M.S. and Ph.D. degrees is offered with opportunity for specialization in stratigraphy, paleontology, paleobotany, palynology, regional and structural geology, geomorphology, coal geology, and metalliferous geology.

Prerequisites for unconditional admission to graduate standing include a bachelor's degree, together with 25 semester hours in an approved combination of chemistry, physics, mathematics, and biological sciences, and at least 18 semester hours in geology and mineralogy.



## GEOLOGY (GEOL)

400. GEOLOGY FOR TEACHERS (3)
420. PALEOBOTANY (3) *Mr. Spackman*
424. GEOLOGY OF COAL (2) *Mr. Nickelsen*
426. INTRODUCTORY PALYNOLOGY (2) *Mr. Kremp*
451. ECONOMIC GEOLOGY (3) *Mr. Burnham*
455. PHYSIOGRAPHY OF NORTH AMERICA (3)
461. GEOLOGY OF THE UNITED STATES (3) *Mr. Nickelsen*
462. PRINCIPLES OF GEOMORPHOLOGY (3-6)
464. PALEONTOLOGY (3) *Mr. Swartz*
481. GEOLOGY OF OIL AND GAS (3) *Mr. Scholten*
482. METALLIC MINERAL DEPOSITS (3) *Mr. Burnham*
483. STRUCTURAL GEOLOGY (3) *Mr. Nickelsen*
484. PALEOZOIC STRATIGRAPHY (3) *Mr. Swartz*
485. PALEONTOLOGY (2) *Mr. Swartz*
486. STRATIGRAPHIC METHODS (1) *Mr. Swartz*
488. EARTH SCIENCES SEMINAR (1)
489. EARTH SCIENCES REPORT (1)
- \*500. GEOLOGY SEMINAR (1-9) Presentation, at weekly departmental meetings, of topics selected from geological literature.
- †501. STRATIGRAPHY (3-12) Principles of stratigraphic classification, lithofacies and biofacies, faunal zonation, correlation, sedimentation, and paleogeography, illustrated by stratigraphy of classical geologic regions: (a) Pre-Cambrian; (b) Paleozoic; (c) Mesozoic; (d) Cenozoic. Prerequisite: Geol. 464. *Mr. Swartz*
- †503. PALEONTOLOGY (3-9) Morphology of animal groups significant for their fossils; nature of species and faunal zones. Seminars may be arranged for studies of special fossil groups, microfossils, paleoecology. *Mr. Swartz*
504. HISTORY OF GEOLOGY (2-3) Development through the ages of the scientific method in earth sciences. Offered in the fall semester of odd years. *Mr. Krynine*
507. SEMINAR IN GEOMORPHOLOGY (3-6) Classic and current literature in geomorphology.
511. ORE DEPOSITS: PRINCIPLES (3-6) Geological and geochemical processes controlling ore deposition; genetic classification of ore deposits. Prerequisite: Geol. 451. *Mr. Ridge*
512. ORE DEPOSITS: TYPES (1-6) Geologic history and field examination of selected ore bodies; forming media; causes, sequences, and loci of emplacement; wall rock alteration; secondary enrichment. Prerequisite: Geol. 511. *Mr. Ridge*
515. ORE MICROSCOPY (2-3) Theory and use of the ore microscope in identifying ore minerals in polished section, establishing paragenetic sequences, determining manner of deposition. *Mr. Burnham*
520. SEMINAR IN PALEOBOTANY (2-6) Current and classic literature concerning evolution, paleoecology, and geologic history of vascular plants. *Mr. Spackman*

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\* Credits to be arranged, 1 to 6 per semester.

† Credits to be arranged, 3 to 6 per semester.

## GEOLOGY

524. COAL PETROLOGY (1-6) Microscopy, source materials, coalification, constitution, classification of peats, lignites, bituminous coal, anthracite. *Mr. Spackman*
526. PROBLEMS IN PALYNOLOGY (3-9) Systematics; paleoecological palynology; Paleozoic palynology; Mesozoic and Cenozoic palynology; Pleistocene vegetational history. *Mr. Kremp*
530. GEOLOGICAL PROBLEMS (3-6) Study, from the literature, of a selected geological problem. Prerequisite: 10 credits in geology and mineralogy.
545. GLACIAL GEOLOGY (3) Glaciers: their characteristics, causes, deposits, land forms, effects in periglacial regions.
551. GEOTECTONICS (3-6) Tectonic principles and elements: nature and development of geosynclines, island arcs, mountain structures, stable masses, cratons, mobile belts. *Mr. Scholten*
555. ADVANCED STRUCTURE AND PETROFABRICS (1-3) Macroscopic and microscopic recognition, measurement, and interpretation of small-scale rock structures and mineral orientation patterns in deformed rocks. *Mr. Nickelsen*
571. PETROLEUM PROVINCES OF THE WORLD (3) Stratigraphy, structure, geologic history, and oil and gas occurrence in major petroliferous provinces. *Mr. Scholten*
590. GEOLOGY FIELD TRIP (1 per year) Field study of regional geologic features with trips in successive years to differing geologic provinces. Required each spring of all graduate students in geology.

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in geological studies are listed under Mineral Sciences in Part II of this bulletin.*

## GEOPHYSICS AND GEOCHEMISTRY

B. F. HOWELL, JR., *Head of the Department*  
219 Mineral Sciences Building

The M.S. and Ph.D. degrees are offered in the field of geophysics (geophysical prospecting, seismology, gravity, well logging, radioactive age determinations, tectonics) and in the field of geochemistry (crystal chemistry, phase equilibria, element distribution and affiliations, isotope geochemistry, geochemical prospecting, cosmochemistry, high temperature and high pressure geochemistry).

For admission to graduate work in geophysics an applicant is generally expected to have had 10 semester hours of geology and mineralogy, 20 of physics and chemistry, and mathematics through differential equations; for geochemistry, 10 semester hours of geology and mineralogy, 24 of chemistry and physics, and mathematics through integral calculus. Students who have taken somewhat less than the indicated minima in these subjects may be admitted but must make up their deficiencies concurrently with their graduate studies.

### GEOPHYSICS AND GEOCHEMISTRY (G G)

401. ELECTRICAL PROSPECTING (3)  
402. SEISMIC PROSPECTING (3)

*Mr. Moore*  
*Mr. Howell*

## GEOPHYSICS AND GEOCHEMISTRY

403. GEOPHYSICS FIELD WORK (1-3) *Mr. Howell*  
 405. INTRODUCTORY GEOPHYSICS (3) *Mr. Howell*  
 406. INTRODUCTORY GEOCHEMISTRY (3) *Mr. Keith*  
 407. WELL LOGGING (2) *Mr. Moore*  
 408. POTENTIAL THEORY APPLIED TO EARTH PROBLEMS (3) *Mr. Moore*  
 409. GEOPHYSICAL PROSPECTING (3) *Mr. Moore*
500. GEOPHYSICAL SEMINAR (1 per semester) Discussion of geophysical reports and papers; scientific outlook. Prerequisites: G.G. 401, 402. *Mr. Howell*
501. RESEARCH (1-15 per semester) Original research in geophysics or geochemistry.
502. SEISMIC INSTRUMENTS (3) Characteristics and design of seismometers and seismic recorders. Prerequisite: Phys. 285, differential equations. Given alternate years. *Mr. Howell*
503. SPECIAL STUDIES IN GEOPHYSICS (1-9) Special studies of the theories of geophysical methods. Prerequisite: 6 credits in geophysics.
507. SEISMOLOGY (3) Nature and transmission of seismic waves; cause and occurrence of earthquakes; applications in seismic prospecting. Prerequisites: Math. 44, Phys. 285. *Mr. Howell*
508. TECTONICS (3) Seminar in the cause and nature of the principal deformations of the earth. Prerequisite: Geol. 483. *Mr. Howell*
509. GEOCHEMISTRY SEMINAR (1 per semester)
510. PROBLEMS IN GEOCHEMISTRY (1-9) Laboratory and library study of special problems. Prerequisite: G.G. 406.
512. PRINCIPLES AND METHODS IN HIGH-TEMPERATURE GEOCHEMISTRY (3) Ion configuration and radii; simple crystal structures; measurement and control of temperature and pressure; methods of phase equilibrium determination. *Mr. Roy*
513. PHASE EQUILIBRIA IN MINERAL SYSTEMS (3-6) Phase relations and constitution of inorganic crystals and liquids; special emphasis on systems closely related to natural magmas and rock systems. Prerequisite: G.G. 512. *Mr. Osborn*
514. ELEMENT DISTRIBUTION IN THE EARTH (3) Principles and data from studies of phase equilibria, petrology, and crystal structure as related to distribution of elements in minerals, rocks, and the earth. *Mr. Herzog*
515. ELECTRIC WELL-LOGGING (2-3) Quantitative and qualitative methods of interpreting electrical resistivity, induction, and self-potential logs; comparison of electrical logging methods. Prerequisites: Phys. 285, Math. 43. *Mr. Moore*
516. NUCLEAR GEOPHYSICS (3) Natural radioactivity and its measurement, spectroscopy, age determinations, geothermometry, radioactive prospecting and logging. *Mr. Clayton*

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in geophysical and geochemical studies are listed under Mineral Sciences in Part II of this bulletin.



## GERMAN

PHILIP A. SHELLEY, *Head of the Department*  
229 Sparks Building

Graduate study in German may lead to the M.A., M.Ed., or Ph.D. degree. There is opportunity for major emphasis upon either literature or philology. Minimum qualifications for admission include 18 undergraduate credits in German; provision is made, however, for admission with limited deficiencies.

## GERMAN (GER)

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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| 400. PROSEMINAR IN BIBLIOGRAPHY AND METHODS OF RESEARCH (2)                                                                                                                   | <i>Mr. Shelley</i>    |
| 401. HISTORY OF THE GERMAN LANGUAGE (3)                                                                                                                                       | <i>Mr. Buffington</i> |
| 402. MIDDLE HIGH GERMAN (3)                                                                                                                                                   | <i>Mr. Buffington</i> |
| 420. GERMAN LITERATURE TO 1700 (3)                                                                                                                                            | <i>Miss Adolf</i>     |
| 421. GERMAN LITERATURE IN THE 18TH CENTURY (3)                                                                                                                                | <i>Mr. Buffington</i> |
| 422. GERMAN LITERATURE IN THE 19TH CENTURY (3)                                                                                                                                | <i>Miss Adolf</i>     |
| 423. GERMAN LITERATURE OF THE 20TH CENTURY (3)                                                                                                                                | <i>Mr. Steiner</i>    |
| 424. GOETHE'S LIFE AND WORKS (3)                                                                                                                                              | <i>Mr. Buffington</i> |
| 426. SCHILLER'S LIFE AND WORKS (3)                                                                                                                                            |                       |
| 443. (C.Lit. 443). LITERARY RELATIONS OF GERMANY WITH ENGLAND AND AMERICA (3-9)                                                                                               | <i>Mr. Shelley</i>    |
| *1G. ELEMENTARY GERMAN FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.                                       |                       |
| *2G. ELEMENTARY GERMAN FOR GRADUATE STUDENTS (3) Continuation of Ger. 1G, with opportunity for reading in special fields.                                                     |                       |
| 501. GERMAN LANGUAGE SEMINAR (3-12) Critical study of special problems in the Germanic languages, with emphasis on Gothic and the High German dialects in different eras.     |                       |
| 515. GERMAN LITERATURE SEMINAR (3-12) Special aspects and characteristics of individual writers and various types and periods of literature.                                  |                       |
| 531. SPECIAL STUDIES IN THE GERMAN LYRIC (3)                                                                                                                                  | <i>Mr. Shelley</i>    |
| 532. SPECIAL STUDIES IN THE GERMAN DRAMA (3)                                                                                                                                  | <i>Miss Adolf</i>     |
| 533. SPECIAL STUDIES IN THE GERMAN SHORT STORY (3)                                                                                                                            | <i>Mr. Steiner</i>    |
| 534. SPECIAL STUDIES IN THE GERMAN NOVEL (3)                                                                                                                                  | <i>Miss Adolf</i>     |
| 552. OLD HIGH GERMAN (3) Essentials of the grammar, with special treatment of the High German sound shift and of ablaut and umlaut. Reading of works written before 1100 A.D. | <i>Mr. Buffington</i> |
| 553. GOTHIC (3) Essentials of the grammar; reading of Ulfilas' Bible translation. Suitable also for advanced students in English.                                             | <i>Miss Adolf</i>     |

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\* No graduate credit is given for this course.

## HISTORY

JOSEPH G. RAYBACK, *Head of the Department*  
116 Sparks Building

Graduate programs are offered leading to the M.A., M.Ed., Ph.D., and D.Ed. degrees. The student may specialize in medieval history, early modern European history, modern European history, colonial American history, 19th century American history, modern American history, or Latin-American history.

The entering student should present evidence of undergraduate course work covering the history of Europe from ancient times to the present and the history of America from its discovery to the present.

## HISTORY (HIST)

- |                                                                               |                                   |
|-------------------------------------------------------------------------------|-----------------------------------|
| 401. ANCIENT CIVILIZATION (3)                                                 | <i>Mr. Dahmus</i>                 |
| 403. THE MIDDLE AGES FROM CONSTANTINE TO THE CRUSADES (3)                     | <i>Mr. Dahmus</i>                 |
| 404. THE MIDDLE AGES FROM THE CRUSADES TO THE RENAISSANCE (3)                 | <i>Mr. Dahmus</i>                 |
| 408. INTELLECTUAL HISTORY OF THE MIDDLE AGES (2-3)                            | <i>Mr. Dahmus</i>                 |
| 410. RENAISSANCE AND REFORMATION (3)                                          | <i>Mr. Green</i>                  |
| 413. THE AGE OF ABSOLUTISM (3)                                                | <i>Mr. Pundt</i>                  |
| 419, 419X. RECENT EUROPEAN HISTORY (3)                                        | <i>Mr. Forster</i>                |
| 420. COLONIAL AMERICA, 1607-1750 (3)                                          |                                   |
| 424. AMERICAN POLITICAL BIOGRAPHY (3)                                         | <i>Messrs. Klein and Murray</i>   |
| 425, 425X. HISTORICAL BACKGROUND OF AMERICAN POLITICAL PARTIES, 1607-1900 (3) | <i>Mr. Rayback</i>                |
| 427. THE DIPLOMATIC HISTORY OF THE UNITED STATES (3)                          | <i>Mr. DeNovo</i>                 |
| 428. AMERICAN MILITARY HISTORY (3)                                            | <i>Mr. Hassler</i>                |
| 431. THE AMERICAN REVOLUTION, 1751-1783 (3)                                   |                                   |
| 432. THE FORMATIVE PERIOD OF AMERICAN HISTORY (3)                             | <i>Messrs. Klein and Colbourn</i> |
| 436, 436X. RECENT AMERICAN HISTORY (3)                                        | <i>Mr. Murray</i>                 |
| 440. HISTORY OF ENGLAND AND GREAT BRITAIN SINCE 1485 (3)                      | <i>Mr. Forster</i>                |
| 441. RECENT HISTORY OF GREAT BRITAIN (3)                                      | <i>Mr. Forster</i>                |
| 442. HISTORY OF RUSSIA TO 1861 (3)                                            | <i>Mr. Thaden</i>                 |
| 443. HISTORY OF MODERN RUSSIA (3)                                             | <i>Mr. Thaden</i>                 |
| 444. EASTERN EUROPE IN MODERN TIMES (3)                                       | <i>Mr. Thaden</i>                 |
| 447. ECONOMIC DEVELOPMENT OF MODERN EUROPE (3)                                | <i>Mr. Pundt</i>                  |
| 448. SOCIAL AND CULTURAL HISTORY OF MODERN EUROPE (3)                         | <i>Mr. Pundt</i>                  |
| 452. SOCIAL AND CULTURAL HISTORY OF THE UNITED STATES SINCE 1783 (3)          | <i>Mr. Brown</i>                  |
| 454. ECONOMIC DEVELOPMENT OF THE UNITED STATES (3)                            | <i>Mr. McNall</i>                 |
| 456. HISTORY OF AMERICAN LABOR (3)                                            | <i>Mr. Rayback</i>                |
| 460. LATIN AMERICA AND THE UNITED STATES (3)                                  | <i>Mr. Gray</i>                   |
| 461. SOCIAL AND CULTURAL HISTORY OF LATIN AMERICA (3)                         | <i>Mr. Gray</i>                   |
| 499X. FOREIGN STUDY IN HISTORY (2-6)                                          |                                   |
| 501. EUROPEAN HISTORIOGRAPHY (3)                                              | <i>Mr. Pundt</i>                  |
| 502. AMERICAN HISTORIOGRAPHY (3)                                              | <i>Mr. Klein</i>                  |
| 504. MEDIEVAL CIVILIZATION (3-9)                                              | <i>Mr. Dahmus</i>                 |
| 505. THE AGE OF THE REFORMATION (3-6)                                         | <i>Mr. Green</i>                  |
| 508. STUDIES IN EUROPEAN HISTORY, 1600-1789 (3-6)                             | <i>Mr. Pundt</i>                  |

## HISTORY

509. EUROPE SINCE 1789 (3-6) Prerequisites: Hist. 18, 19. *Messrs. Pundt and Forster*
512. STUDIES IN PENNSYLVANIA HISTORY (3-6) *Mr. Klein*
520. COLONIAL AND REVOLUTIONARY AMERICA (3-6) Prerequisites: Hist. 20, 21. *Mr. Colbourn*
533. THE UNITED STATES, 1783-1860 (3-6) *Mr. Klein*
534. THE UNITED STATES, 1860-1900 (3-6) Prerequisites: Hist. 20, 21. *Mr. Brown*
536. THE UNITED STATES IN THE 20TH CENTURY (3-6) *Mr. Murray*
538. DIPLOMATIC HISTORY OF THE UNITED STATES (3) *Messrs. Gray and DeNovo*
539. ECONOMIC HISTORY OF THE UNITED STATES (3) *Mr. McNall*
540. STUDIES IN BRITISH HISTORY (3-6) *Mr. Forster*
550. PROBLEMS IN HISTORY (3-6)
562. SEMINAR IN LATIN-AMERICAN HISTORY (3-6) Prerequisites: Hist. 22, 23. *Mr. Gray*
563. STUDIES IN THE HISTORY OF THE CARIBBEAN AREA (3) Prerequisites: Hist. 22, 23. *Mr. Gray*

## HOME ART

CHRISTINE F. SALMON, *Chairman of the Division*  
219 Home Economics Building

No advanced degree is offered in this field, but a candidate with a major in another field may choose a minor in home art upon approval by his major department.

### HOME ART (H ART)

400. SPECIAL PROBLEMS IN HOME FURNISHINGS (3)
- 433, 433X. ADVANCED HOME CRAFTS (2-12)
434. THE ART AND THE CRAFTS IN THE HOMEMAKING PROGRAM (3-6)
- 440, 440X. HOME FURNISHING PROBLEMS (3)
443. HOME ARTS IN THE ADULT PROGRAM (3)
- 444, 444X. HOME FURNISHING TEACHING PROBLEMS (3)
- 447, 447X. HOME FURNISHINGS FOR THE FAMILY (3)
515. BACKGROUNDS OF THE HOME ARTS (3) Evaluation of useful objects in respect to their form, function, and time; selections for exhibition. Prerequisites: H.Art 216 or Art 15 or A.Ed. 6, and A.A.H. 1 or H.Art 240.
530. PROBLEMS IN HOME ART (1-6) Individual investigation, analysis, and presentation. Prerequisite: 6 credits in home art, art education, or art.
541. ART IN THE ENVIRONMENT (3) Approach based upon human needs with consideration of materials in the light of their use in home living. Prerequisite: Art 14 or A.Ed. 5 or H.Art 440.



## HOME ECONOMICS EDUCATION

MARJORIE EAST, *Head of the Department*  
119C Home Economics Building

The department offers graduate work leading to the M.S., M.Ed., Ph.D., and D.Ed. degrees. Research and graduate courses may be chosen to give emphasis to special areas of interest in home economics education, such as curriculum development; evaluation; teaching at the elementary, secondary, adult, or higher education levels; supervision; administration in colleges; or research.

The student wishing to study for a graduate degree in this field should present approximately 50 semester hours of undergraduate work from the following areas: home economics education, education and/or psychology, aspects of home economics; the physical and biological sciences; and the social sciences.

## HOME ECONOMICS EDUCATION (HE ED)

- 406, 406v, 406X, 406vX. TEACHING AIDS IN FAMILY LIFE EDUCATION (1-4)  
 427, 427v, 427X, 427vX. FAMILY LIFE EDUCATION (3)  
 443, 443v, 443X, 443vX. ADULT HOMEMAKING EDUCATION (3)  
 463, 463v. SENIOR SEMINAR (1)  
 \*466, 466v. STUDENT TEACHING (9)  
 478, 478v, 478X, 478vX. APPRAISING STUDENT PROGRESS IN EDUCATION FOR FAMILY LIVING (3)  
 479, 479v, 479X, 479vX. READINGS IN HOME ECONOMICS EDUCATION (1-4)
- 502, 502v. HOME ECONOMICS INSTRUCTION AT THE COLLEGE LEVEL (3) Teaching techniques suitable for college instruction in home economics; for prospective home economics college teachers not majoring in home economics education.
- 503, 503v. PROBLEMS IN HOME ECONOMICS TEACHER EDUCATION (3) Organization of college programs of teacher education; use of resources; records; field services; recruitment and selection of personnel. Prerequisite: at least two years of experience in teaching home economics.
- 504, 504v. CURRENT DEVELOPMENTS IN EDUCATION IN RELATION TO HOME ECONOMICS (3) Opportunity for home economists to study newer developments in education. Prerequisite: one year of teaching experience in home economics. *Mrs. East*
- 505, 505v, 505X, 505vX. PRACTICUM IN TEACHING HOME ECONOMICS IN THE SECONDARY SCHOOL (3-6) Projects in home economics education which may be carried out in the school in which the teacher is regularly employed. *Miss Hillier*
- 509, 509v, 509X, 509vX. CURRICULUM WORKSHOP IN FAMILY LIFE EDUCATION (3) Laboratory course in problems of curriculum building; individual problems in this field; frequent individual and group conferences. Prerequisite: one year's experience in teaching home economics. *Mrs. East, Miss Hatcher, or Miss Hillier*
- 510, 510v, 510X, 510vX. THE SUPERVISION OF HOME ECONOMICS TEACHING (2-6) For teachers of home economics desiring to qualify as city, county, or student teacher supervisors. Prerequisite: graduation from a four-year teacher education curriculum and two years' teaching experience in home economics.

*Mrs. East or Miss Hillier*

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\* A grade point average of 2.2 in all previous work is prerequisite to each course in student teaching.

## HOME ECONOMICS EDUCATION

- 518, 518v, 518X, 518vX. EVALUATION IN FAMILY LIFE EDUCATION (3) Methods of evaluating progress toward goals in home economics education and use of findings in program planning and revision. *Mrs. East, Miss Hatcher, or Miss Hillier*
- 521, 521v, 521X, 521vX. HOME ECONOMICS EDUCATION SEMINAR (2-3) Selected topics and recent developments in education for family living. Conferences and guidance relative to individual research problems. *Mrs. East or Miss Hatcher*
- 526, 526v, 526X, 526vX. THE COMMUNITY PROGRAM IN FAMILY LIFE EDUCATION (2-3) Ways of discovering community needs and resources; methods of developing the community program in family living; leadership education for the lay member of the community.
- 530, 530v. PROBLEMS IN HOME ECONOMICS EDUCATION (1-6 per semester) Individual investigation of problems related to the teaching, supervision, or administration of home economics education.

## HOME MANAGEMENT AND FAMILY ECONOMICS

DELPHA E. WIESENDANGER

*Head of the Department of Home Management, Housing, and Home Art*  
109A Home Economics Building

The M.Ed., M.S., D.Ed., and Ph.D. degrees are offered with a major in home management and family economics. Family management practices, their effects upon members of the family unit, and the interaction of such practices with the local and national economy are studied in relation to principles of economics, philosophy, psychology, sociology, and political science.

Those interested in emphasizing a study of home management, family economics, family housing, and home equipment may do so through this major. There are no specific course requirements for admission.

### HOUSING AND HOME EQUIPMENT (HS EQ)

- 413, 413X. HOME EQUIPMENT (3)  
470, 470X. HOUSING THE FAMILY (2-3)

### HOME MANAGEMENT AND FAMILY ECONOMICS (HM FE)

- 415, 415X. HOUSEHOLD BUYING PRACTICES (3)  
419, 419X. MANAGING FAMILY FINANCIAL RESOURCES (3) *Mrs. Honey*  
423, 423X. (F.N. 423). FAMILY FOOD PURCHASING (2)  
424, 424X. ECONOMIC CONDITIONS IN RELATION TO THE FAMILY (3) *Miss Britton*  
439, 439X. HOME MANAGEMENT (2) *Miss Starr*  
442. RESIDENT EXPERIENCE IN HOME MANAGEMENT (3) Room and board will be charged at regular rates. *Miss Starr*  
445. HOME MANAGEMENT EXPERIENCE (3) *Miss Starr*  
477. FAMILY MANAGEMENT (3)

- 515, 515X. CONSUMER PROBLEMS (2-3) Methods of securing, evaluating, and presenting data concerning household commodities. For home economics teachers in high schools, colleges, and adult classes. Prerequisites: F.N. 220, H.M.F.E. 442.

## HOME MANAGEMENT AND FAMILY ECONOMICS

524. ECONOMIC PROBLEMS OF THE HOUSEHOLD (3) Economic problems of the present-day family; special emphasis on factors in household production, use of money income, and standards of living. Prerequisites: H.M.F.E. 439, Econ. 14.  
*Miss Britton*
528. HOME MANAGEMENT SUPERVISION (2-3) Evaluation of objectives and techniques in organization, supervision, and teaching of the home management house experience. Prerequisite: H.M.F.E. 439.
543. HOME MANAGEMENT IN RELATION TO FAMILY LIVING (3) Includes work with families in solution of their management problems. Prerequisites: F.N. 220, H.M.F.E. 439.  
*Miss Wiesendanger*
544. PROBLEMS IN HOME MANAGEMENT AND FAMILY ECONOMICS (1-6) Investigation of selected problems in home management and family economics. Prerequisite: 6 credits of home management or family economics courses in home economics.
550. SEMINAR IN HOME MANAGEMENT AND FAMILY ECONOMICS (1-6) Discussion and reports on developments in home management and family economics.

## HORTICULTURE

RUSSELL E. LARSON, *Head of the Department*  
102 Tyson Building

The department offers major work for the M.S. and Ph.D. degrees with specialization in propagation, production, processing, breeding, nutrition, and other physiological studies of horticultural crop species. Students may also specialize in the field of landscape design.

The prerequisite to major graduate study in horticulture is the completion of an undergraduate curriculum substantially equivalent to one of the horticulture options or curriculums at this University.

### HORTICULTURE (HORT)

- |                                                     |                    |
|-----------------------------------------------------|--------------------|
| 412. STORAGE OF HORTICULTURAL CROPS (3)             | <i>Mr. Ritter</i>  |
| 418. SUBTROPICAL AND TROPICAL FRUITS (3)            |                    |
| 420. ADVANCED COMMERCIAL VEGETABLE PRODUCTION (3)   | <i>Mr. Odland</i>  |
| 424. ADVANCED OLERICULTURE (3-6)                    | <i>Mr. Odland</i>  |
| 425. ADVANCED FRUIT AND VEGETABLE PROCESSING I (3)  | <i>Mr. Thomas</i>  |
| 426. ADVANCED FRUIT AND VEGETABLE PROCESSING II (3) | <i>Mr. Thomas</i>  |
| 427. ADVANCED FLORICULTURE (3)                      | <i>Mr. Boodley</i> |
| 428. ADVANCED FLORICULTURE (3)                      | <i>Mr. Boodley</i> |
| 444. ADVANCED PLANT BREEDING (3-6)                  | <i>Mr. Walker</i>  |
| 446. ADVANCED POMOLOGY (3)                          |                    |
| 447. PROBLEMS IN HORTICULTURE (1-6)                 |                    |
| 453. NURSERY PRINCIPLES AND PRACTICE (3)            | <i>Mr. Meahl</i>   |
| 456. PROBLEMS IN NURSERY PRACTICE (3)               | <i>Mr. Meahl</i>   |
500. ECOLOGY OF FRUIT PLANTS (3) Factors limiting the distribution and intensity of culture of fruit species and varieties and effect of environmental factors on cultural practices.



## HORTICULTURE

501. EXPERIMENTAL PROBLEMS IN POMOLOGY (2-12) Investigation of problems involving review of literature, field and laboratory research.
503. EXPERIMENTAL PLANT BREEDING (2-12) Problems based mainly on research work of the department, with review of experimental methods and literature. Prerequisite: Hort. 444. *Mr. Larson*
504. EXPERIMENTAL PROBLEMS IN OLERICULTURE (2-9) Investigation of problems involving review of literature, field and laboratory research. Prerequisite: Hort. 420 or 424. *Mr. Odland*
505. PROBLEMS IN VEGETABLE PRODUCTION (2-6) Methods used in the more valuable contributions to vegetable production. Prerequisite: Hort. 420 or 424. *Mr. Odland*
506. NUTRITION OF HORTICULTURAL CROPS (2-4) Principles, applications, and interpretations of diagnostic methods for determining fertilizer requirements of horticultural crops. *Mr. Smith*
512. PRINCIPLES OF FRUIT AND VEGETABLE STORAGE (2-4) Principles involved in the maturation, storage, and senescence of fruits and vegetables, and their application. *Mr. Ritter*
513. EXPERIMENTAL PROBLEMS IN ORNAMENTAL HORTICULTURE (2-12) Review of research in ornamental horticulture, with original investigations. *Mr. Meahl*
514. PROPAGATION OF ORNAMENTAL AND FRUIT PLANTS (3) Factors affecting the asexual and sexual propagation of fruit and ornamental plants. *Mr. Meahl*
517. HORTICULTURE SEMINAR (1 per semester) Review of current research publications in horticulture. Each student presents one or more reviews of assigned topics.
519. SEMINAR ON THE GENETICS OF HORTICULTURAL CROPS (1 per semester) Review of current research publications on the genetics of horticultural crops. Each student presents one or more reviews of literature on assigned topics.
520. SEMINAR ON THE BREEDING OF HORTICULTURAL CROPS (1 per semester) Each student presents one or more reviews of literature on assigned topics.
523. PROPAGATION AND IMPROVEMENT OF VEGETABLE AND FLOWER CROPS (3) Methods and special techniques in breeding of flowers and vegetables; maintenance of seed stocks and seed production. Prerequisite: Hort. 444. *Mr. Odland*
524. EXPERIMENTAL PROCEDURES IN HORTICULTURAL RESEARCH (3) *Mr. Larson*
525. HORTICULTURAL RESEARCH TECHNIQUES (3) Practice in and comparison of methods and apparatus used in horticultural research.
526. EXPERIMENTAL PROBLEMS IN FLORICULTURE (2-12) Greenhouse research and review of literature. Prerequisite or concurrent: Hort. 427, 428. *Mr. Mastalerz*
527. EXPERIMENTAL PROBLEMS IN NUTRITION OF HORTICULTURAL CROPS (2-12) Review of current research; problems for independent investigation. *Mr. Smith*
528. PROBLEMS IN FRUIT AND VEGETABLE PROCESSING (2-12) *Mr. Thomas*

## LANDSCAPE ARCHITECTURE (L ARCH)

434. (Rc.Ed. 434). RECREATION AREAS AND FACILITIES (3) *Mr. Wilson*
- 454-455. LANDSCAPE DESIGN (4 each)

460. ADVANCED LANDSCAPE DESIGN (3-6)  
 461. PARK DESIGN AND ADMINISTRATION (3-6) *Mr. Wilson*  
 462. SITE PLANNING OF INSTITUTIONAL AND PUBLIC PROJECTS (3-6) *Mr. Wilson*  
 463. ADVANCED LANDSCAPE DESIGN (1-6)
518. ADVANCED PROBLEMS IN LANDSCAPE DESIGN (2-12) Selected problems for original investigation in the design, construction, and maintenance of landscape architectural projects. Prerequisite: L.Arch. 455.
521. TECHNICAL LANDSCAPE ARCHITECTURAL PRACTICES (2-12) Specific technical and professional problems in landscape architectural planning and practice. Prerequisites: L.Arch. 460, 461.

## INDUSTRIAL EDUCATION

S. LEWIS LAND, *Head of the Department*  
 301 Burrowes Building

Graduate work in this department may lead to the M.Ed., M.S., D.Ed., or Ph.D. degree with majors in industrial arts education and vocational industrial education. Emphasis may be placed on improved teaching, supervision and administration, or preparation for teacher education.

The minimum undergraduate preparation includes graduation from an approved curriculum in the major area.

### INDUSTRIAL ARTS (I ART)

- 400, 400X. SHOP MANAGEMENT AND LAYOUT (2-3)  
 407, 407X. INDUSTRIAL ARTS EDUCATION (2-3)  
 421, 421X. CURRICULUM MATERIALS IN INDUSTRIAL ARTS (2-3)  
 470, 470X. PROBLEMS IN SENIOR HIGH SCHOOL INDUSTRIAL ARTS (2-3)
574. HISTORY AND PHILOSOPHY OF INDUSTRIAL ARTS (2-3) Historical developments and concurrent educational philosophies of industrial arts in American education. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.
575. PROBLEMS IN INDUSTRIAL ARTS EDUCATION (2-3) Subject matter, projects, methods of manual and informational teaching, aids and devices, selection of text and reference materials, personnel organization, shop management, problem pupils. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.
576. SUPERVISION AND ADMINISTRATION OF INDUSTRIAL ARTS EDUCATION (2-3) How to organize, supervise, and administer functioning programs of industrial arts; duties of a supervisor and director of industrial arts. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.
577. TESTING IN INDUSTRIAL ARTS (2-3) Construction of informal manipulative and written tests; use of standardized mechanical aptitude and achievement tests; construction and use of rating scales; scoring and grading; interpretation of test re-

## INDUSTRIAL EDUCATION

sults. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.

578. RESEARCH IN INDUSTRIAL ARTS (2-3) Research techniques in industrial arts education. Prerequisite: 6 credits in professional courses in industrial arts.

580. SEMINAR IN INDUSTRIAL ARTS (2-9) Directed intensive study, investigation, or research in selected phases of the program; reports and constructive criticism. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.

### INDUSTRIAL EDUCATION (I ED)

401v, 401vX. HISTORY OF INDUSTRIAL EDUCATION (2-3)

402v, 402vX. SUPERVISION OF VOCATIONAL EDUCATION (2-3)

403v, 403vX. SUPERVISED FIELD WORK (1-6)

405v, 405vX. CONFERENCE LEADER TRAINING (2-3)

408v, 408vX. OCCUPATIONS (2-3)

409v, 409vX. TESTS AND MEASUREMENTS (2-3)

412v, 412vX. SPECIAL PROBLEMS IN VOCATIONAL EDUCATION (2-4)

414v, 414vX. VOCATIONAL EDUCATIONAL GUIDANCE (2-3)

415v, 415vX. PROBLEMS IN CO-ORDINATING VOCATIONAL EDUCATION (2-3)

418v, 418vX. PROBLEMS IN AUDIO-VISUAL AIDS IN INDUSTRIAL EDUCATION (2-3)

420v, 420vX. OCCUPATIONAL HYGIENE (2-3)

425v, 425vX. WORKSHOP IN INDUSTRIAL EDUCATION (1-6)

427v, 427vX. ADVANCED COURSE OF STUDY BUILDING (2-3)

446v, 446vX. IMPROVEMENT OF INSTRUCTION IN VOCATIONAL EDUCATION (2-4)

450v, 450vX. SHOP LAYOUT AND MANAGEMENT (2-3)

458v. EMERGING PROBLEMS IN VOCATIONAL EDUCATION (1-7)

Unit A. *Federal and State Laws Relating to Vocational Education* (1)

Unit B. *Framework of Federal, State, and Local Administrative Agencies* (1)

Unit C. *Federal, State, and Local Policies and Plans for Vocational Education* (1)

Unit D. *Local Administration of Vocational Education* (1)

Unit E. *Labor Laws and Labor Relations Affecting Education* (1)

Unit F. *Vocational Training for War and Postwar Eras* (1)

Unit G. *Problems in Vocational Rehabilitation of the Physically Handicapped* (1)

460. PROBLEMS IN VOCATIONAL REHABILITATION OF THE HANDICAPPED (1-6)

Unit A. *The Counseling Interview in Vocational Rehabilitation* (1-3)

Unit B. *Occupational Information and Placement Techniques in Vocational Rehabilitation* (1-3)

501v. SEMINAR IN VOCATIONAL EDUCATION (1-12) Conferences, investigations, and discussion for advanced students and mature persons who have had experience as teachers, supervisors, or administrators.

506v. ADMINISTRATION OF VOCATIONAL EDUCATION (1-6) The job of the local director of industrial education in organizing and developing city and other local programs of industrial education. Prerequisite: 6 credits in industrial education or valid director's certificate, equivalent training and experience.

510v. VOCATIONAL EDUCATION FOR ADMINISTRATORS (2-3) Designed for school administrators and supervisors who desire an understanding of practical arts and vocational education. Prerequisite: I.Ed. 1v or trade or teaching experience.



550v. RESEARCH IN VOCATIONAL EDUCATION (2-3) Research techniques in vocational industrial education.

555v. CURRENT PROBLEMS IN VOCATIONAL EDUCATION (1-6) Recent trends and developments in part-time, full-time, and evening school education, involving critical analysis of objectives, content, and outcome.

*Unit A. Changing Industrial, Economic, and Social Conditions (1)*

*Unit B. Policies and Program of the American Vocational Association (1)*

*Unit C. Federal and State Vocational Legislation, Present and Pending (1)*

*Unit D. Financing Vocational Education (1)*

*Unit E. Current Administrative Problems in Vocational Education (1)*

*Unit F. Current Administrative Problems in Vocational Education (cont'd) (1)*

558v. FRONTIER PROBLEMS IN VOCATIONAL INDUSTRIAL EDUCATION (2-3 per unit)

*Unit A. Federal Legislation (2-3)*

*Unit B. Present-Day Local Personnel and Curriculum Problems (2-3)*

*Unit C. State and Local Supervision and Administration (2-3)*

560v. PHILOSOPHY OF INDUSTRIAL EDUCATION (2-3) Principles and beliefs upon which progressive industrial education rests; basic concepts underlying practical arts and vocational education; literature for evaluating instructional practices. Prerequisite: 12 credits in industrial education or teaching experience.

## INDUSTRIAL ENGINEERING

BENJAMIN W. NIEBEL, *Head of the Department*  
203 Engineering C

The department offers graduate work leading to the M.S. degree. Graduate study and research are conducted in operations research, linear programming, queueing theory, and experimental design. Opportunities also exist for advanced study in automation, production engineering, product design for production, work measurement, costs and budgets, tool design, methods analysis, personnel management, and management controls.

In order to be admitted to graduate work in this field, the student must have been graduated from an accredited school with a major in industrial engineering. Graduates of other accredited engineering curriculums may be admitted after completing 27 credits in industrial engineering.

### INDUSTRIAL ENGINEERING (I E)

400. ENGINEERING FOR PRODUCTION (3)

*Mr. Niebel*

402, 402X. ENGINEERING ECONOMY (3)

*Messrs. Niebel, Roscoe, and Thuring*

404. SCIENTIFIC MANAGEMENT (2)

*Messrs. Caldwell and Roscoe*

406. FACTORY PLANNING (2)

*Messrs. Thuring and Linsky*

422a,b,c,d,e,f, 422a,b,c,d,e,fX. INDUSTRIAL ENGINEERING PROBLEMS (2-12)

*Messrs. Niebel, Thuring, Linsky, and Moss*

423. QUALITY CONTROL (2)

*Mr. Thuring*

424. JOB EVALUATION (3)

*Mr. Thomas*

425, 425X. METHODS OF INDUSTRIAL OPERATIONS RESEARCH (3)

429. PLASTIC WORKING OF METALS (3)

*Mr. Roscoe*

430, 430X. INDUSTRIAL LEADERSHIP (3)

*Mr. Caldwell*

432. INDUSTRIAL ENGINEERING LECTURES (1-3)

## INDUSTRIAL ENGINEERING

501. MANUFACTURING METHODS (2-8) Special projects including investigation; experimentation, design, and research of some one or more special types of manufacture. *Messrs. Niebel and Thuering*
502. MANAGEMENT METHODS (3-6) Scientific management, including management controls and mathematical programming; research on special problems. *Mr. Thuering*
503. PERSONNEL RELATIONS (2-8) Research on special topics. *Mr. Williamson*
505. GRAPHICAL COMPUTATION (2-6) Construction of natural and logarithmic scales, applications of various co-ordinate papers and construction of nomographic or alignment charts; determination of empirical formulae from engineering data. *Mr. Thuering*
506. TIME AND MOTION STUDY (3-9) Methods of research in motion and time study; critical analysis of current literature.
507. BUDGETARY CONTROL AND STANDARD COSTS (3-6) Divisional budgets as control media; establishing standard cost data, standard cost accounting procedures, and use of cost variances in controlling manufacturing operations. Prerequisite: I.E. 335.

## INSTITUTION ADMINISTRATION

ESTHER A. ATKINSON

*Head of the Department of Hotel and Institution Administration*  
4D Home Economics Building

The Department of Hotel and Institution Administration offers graduate work leading to the M.S. degree in institution administration. Prerequisite to graduate work is the completion of the following undergraduate work: 12 semester hours in the physical and biological sciences, 9 semester hours in the social sciences, 6 semester hours in foods and nutrition, and 9 semester hours in institution administration including one course in quantity food preparation.

### HOTEL ADMINISTRATION (H A)

440. HOTEL OPERATIONAL LIABILITIES (2)  
445. HOTEL ORGANIZATION AND OPERATION (3)

### INSTITUTION ADMINISTRATION (IN A)

410. TEA ROOM MANAGEMENT (3)  
437. SCHOOL CAFETERIA PROBLEMS (1-3)  
    *Unit A. Nutrition and Menu Planning (1)*  
    *Unit B. Equipment (1)*  
    *Unit C. Organization and Management (1)*  
438. SCHOOL LUNCH ADMINISTRATION (3)  
461. INSTITUTION ADMINISTRATION (3)  
462. INSTITUTION EXPERIENCE (3)

502. PROBLEMS IN INSTITUTIONAL ADMINISTRATION (3-6) Individual study of problems in institutional administration. Prerequisites: In.A. 326, 330. *Miss Atkinson*

## JOURNALISM

JAMES W. MARKHAM, *Professor of Journalism*  
115 Carnegie Building

The School of Journalism offers graduate work leading to the M.A. degree in journalism with concentration on either editorial journalism or advertising.

The entering student should present the equivalent of an undergraduate major in journalism. Lacking this, he may make up the deficiency by completing basic undergraduate courses specified by the School. Up to 18 credits may be required. The deficiency also may be made up by submission of evidence of adequate professional experience in journalism, or by completion of examinations testing the student's knowledge of journalism fundamentals.

## JOURNALISM (JOURN)

- |                                                                                                                                                                                                                         |                                   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| 401. THE PRESS, ITS CRITICS AND ETHICS (3)                                                                                                                                                                              | <i>Mr. Marbut</i>                 |
| 416. ADVANCED COPY READING (3)                                                                                                                                                                                          | <i>Messrs. Pockrass and Brown</i> |
| 424. ADVANCED REPORTING (3)                                                                                                                                                                                             | <i>Mr. Marbut</i>                 |
| 430. SUPERVISION AND MANAGEMENT OF SCHOOL PUBLICATIONS (3)                                                                                                                                                              |                                   |
| 441. ADVANCED ADVERTISING COPYWRITING (3)                                                                                                                                                                               | <i>Messrs. Davis and Hicks</i>    |
| 466. PUBLICITY AND PUBLIC RELATIONS PROBLEMS (3)                                                                                                                                                                        |                                   |
| 480. PROBLEMS OF PUBLISHING (3)                                                                                                                                                                                         | <i>Messrs. Markham and Vairo</i>  |
|                                                                                                                                                                                                                         |                                   |
| 504. SEMINAR IN PENNSYLVANIA PRESS HISTORY (3)                                                                                                                                                                          | <i>Mr. Marbut</i>                 |
| 505. INTERNATIONAL PRESS PROBLEMS (3-6) Legal and communications problems of the international flow of news and opinion; international press codes.                                                                     | <i>Mr. Markham</i>                |
| 506. SEMINAR IN COMMUNICATIONS RESEARCH METHODS (3-6) Social science measuring techniques for readership and advertising studies, media effectiveness, and propaganda results.                                          | <i>Mr. Markham</i>                |
| 513. CURRENT PROBLEMS IN NEWS REPORTING AND EDITING (3) Securing, writing, display, and treatment of the news; newsroom policies and ethics.                                                                            | <i>Mr. Marbut</i>                 |
| 521. NEWS MEDIA AND PUBLIC OPINION (3) Problems in the function, techniques, and responsibilities of press, radio, and television in forming and interpreting opinion. Prerequisite: Pl.Sc. 427, Psy. 429, or Soc. 431. | <i>Mr. Brown</i>                  |
| 568. SEMINAR IN LEGAL PROBLEMS IN FREEDOM OF THE PRESS (3-6)                                                                                                                                                            | <i>Mr. Marbut</i>                 |

## MATHEMATICS

ORRIN FRINK, *Head of the Department*  
210 Sparks Building

Graduate work leading to the M.A. and Ph.D. degrees is offered. To be admitted without undergraduate deficiency, an applicant should have credit for at least two advanced courses beyond integral calculus.



## MATHEMATICS

Graduate courses in all the principal branches of mathematics are offered each year. The department is equipped to direct research in a variety of fields, including function theory, abstract algebra, topology, number theory, statistics, numerical analysis, and all aspects of mathematical logic and foundations. A digital computer is available on the campus for students interested in numerical methods.

### MATHEMATICS (MATH)

- 403. MODERN METHODS IN GEOMETRY (3)
- 404. THEORY OF NUMBERS (3)
- 405, 405X. PARTIAL DIFFERENTIAL EQUATIONS (3)
- 407. FOUNDATIONS OF ALGEBRA AND GEOMETRY (3)
- 408. APPLICATIONS OF MATHEMATICS (3)
- 409-410, 409X-410X. PROBABILITY AND STATISTICS (3 each)
- 411. FINITE DIFFERENCES (3)
- 412. ALGEBRAIC EQUATIONS (3)
- 413-414, 413X-414X. MATHEMATICS OF SCIENCE FOR TEACHERS (3 each)
- 417. VECTOR AND TENSOR ANALYSIS (3)
- 419. ANALYTICAL MECHANICS (3)
- 420-421. ADVANCED CALCULUS (3 each)
- 424. LEAST SQUARES (2)
- 425. CURVE FITTING (1)
- 428. (Phil. 428). LOGICAL THEORY (3)
- 431. DIFFERENTIAL EQUATIONS (3)
- 441. DETERMINANTS AND MATRICES (3)
- 451-452, 451X-452X. INTRODUCTION TO APPLIED MATHEMATICS (3-6 each)
- 453. MATHEMATICS FOR DIGITAL COMPUTERS (3)
- 471. FOUNDATIONS OF ALGEBRA (3)
- 472. FOUNDATIONS OF GEOMETRY (3)
- 481. VECTORS AND MATRICES (3)
  
- 500. ANALYTICAL MECHANICS (3) An exposition of rigid dynamics, the potential function, and Lagrange's equations. Prerequisite: Math. 419 or Phys. 461.
- 501-502. THEORY OF FUNCTIONS OF A REAL VARIABLE (3 each) Theory of real functions, sets, measure, derivatives, and integrals. Prerequisite: Math. 420.
- 503. FOURIER SERIES AND HARMONIC FUNCTIONS (3) Fourier series and integrals; spherical harmonics, Bessel functions, etc., with special emphasis on their applications. Prerequisites: Math. 44, 420.
- 505. INTEGRAL EQUATIONS (3) Fredholm and Volterra equations, and applications. Prerequisite: Math. 421.
- 507. CALCULUS OF VARIATIONS (3) Prerequisites: Math. 44, 421.
- 508-509. THEORY OF FUNCTIONS OF A COMPLEX VARIABLE (3 each) Development of the complex number system; theory of analytic functions. Prerequisite: Math. 421.
- 510. THEORY OF GROUPS (3) General properties of groups with applications. Prerequisite: Math. 471 or 535.
- 511. LINEAR ALGEBRA AND MATRIX THEORY (3) Vector spaces and linear transformations, canonical representations, elementary divisors and invariant factors. Prerequisite: Math. 481.

- 513-514. **ADVANCED ANALYTIC GEOMETRY** (3 each) Introduction of homogeneous coordinates and their use in the study of projective properties. Prerequisite: Math. 43.
- 520-521. **PROJECTIVE GEOMETRY** (3 each) General study of the subject from the postulational standpoint. Prerequisite: Math. 43. Alternate years or as required.
- 522-523. **METRIC DIFFERENTIAL GEOMETRY** (3 each) The usual classical treatment of the subject. Prerequisite: Math. 43.
- 530-531. **TOPOLOGY** (3 each) Topological spaces, combinatorial topology, applications to algebra and analysis.
534. **THEORY OF ALGEBRAIC NUMBERS** (3) Introduction to the number theory of quadratic fields, with study of the theory of ideals in quadratic and higher fields, with application. Prerequisites: Math. 404, 471.
- 535-536. **MODERN ALGEBRAIC THEORIES** (3 each) Groups, rings, ideals, algebraic number fields, Galois theory. Prerequisite: Math. 471.
- 542-543. **THEORY OF STATISTICS** (3 each) Univariate and multivariate distributions, sampling distributions, theory of estimation, statistical hypotheses. Prerequisites: Math. 409, 421.
- 550-551. **MATHEMATICAL LOGIC** (3 each) The logical basis of mathematics and its ultimate nature. Prerequisite: Math. 471 or Phil. 428.
- 552-553. **NUMERICAL METHODS** (3 each) Procedures for practical calculation, including interpolation, solution of equations, iterative methods, harmonic analysis and use of modern calculating equipment. Prerequisite: Math. 420.
- 560-561. **THEORY OF DIFFERENTIAL EQUATIONS** (3 each) Prerequisites: Math. 44, 421.
570. **SPECIAL TOPICS IN GEOMETRY** (3-6)
571. **SPECIAL TOPICS IN ANALYSIS** (3-6)
572. **SPECIAL TOPICS IN ALGEBRA** (3-6)
573. **SPECIAL TOPICS IN APPLIED MATHEMATICS** (3-6)
574. **SPECIAL TOPICS IN FOUNDATIONS OF MATHEMATICS** (3-6)
- 575-576. **MATHEMATICS SEMINAR** (1-6 each) Selected topics from recent mathematical developments.

## MECHANICAL ENGINEERING

NORMAN R. SPARKS, *Head of the Department*  
208 Mechanical Engineering Building

The department offers graduate work leading to the M.S. and Ph.D. degrees. Graduate programs in this field emphasize heat power or machine design. Courses and facilities available permit studies in heat transfer, advanced machine design, internal combustion engines, machine dynamics, gas turbines and gas dynamics, lubrication, automatic control systems, and power generation and utilization.

## MECHANICAL ENGINEERING

The minimum undergraduate preparation for admission is an educational background approximately equivalent to that of graduates in mechanical engineering at this University. Applicants who cannot completely satisfy this requirement may be admitted, but will be required to make up undergraduate deficiencies without graduate credit.

### MECHANICAL ENGINEERING (M E)

- 401a,b,c,d. MECHANICAL ENGINEERING (3-12)
- 402. AIR CONDITIONING (3)
- 408. STEAM TURBINES (3)
- 409. GAS TURBINES (3)
- 410. POWER PLANTS (3)
- 411, 411X. REFRIGERATION (3)
- 412, 412X. FUNDAMENTALS OF HEAT TRANSFER (3)
- 413. INTERNAL COMBUSTION ENGINES (3)
- 416. RESISTANCE AND POWERING OF SHIPS (3)
- 417. THEORY OF ENGINEERING INSTRUMENTS (3)
- 450. DESIGN OF MACHINE TOOLS (3)
- 451. ADVANCED MACHINE DESIGN PROBLEMS (3)
- 452. MACHINE DESIGN ANALYSIS (3)
- 453. BEARING DESIGN AND LUBRICATION (3)
- 455. AUTOMATIC CONTROL SYSTEMS (3)
- 457. ADVANCED MECHANISMS (3)
  
- 502. ADVANCED GAS TURBINES (3-6) Thermodynamic and stress analysis design of gas turbine and compressor units. Prerequisite: M.E. 409.
- 504. ADVANCED ENGINEERING THERMODYNAMICS (3-6) Pure and applied thermodynamics including its application to advanced engineering problems; collateral reading and discussion of the classical works on the subject. Prerequisite: M.E. 32.
- 505. HEAT TRANSMISSION (3-6) Applications of principles of heat transfer to efficient design of mechanical engineering equipment. Prerequisite: M.E. 412.
- 506. MECHANICAL ENGINEERING SEMINAR (1-4) Advanced courses adapted to the individual requirements of graduates in mechanical engineering.
- 507. ADVANCED INTERNAL COMBUSTION ENGINES (3) Performance and design of carburetor and fuel-injection reciprocating engines, including compound and free-piston types, from the thermodynamic viewpoint. Prerequisite: M.E. 413.
- 510. MIXTURE PREPARATION AND COMBUSTION IN INTERNAL COMBUSTION ENGINES (3-6) Performance and design of carburetors and injection systems; combustion and its control in spark-ignition and compression-ignition engines. Prerequisite: M.E. 413.
- 552. ADVANCED DYNAMICS OF MACHINES (3-6) Linear and torsional vibrations in and balancing of rotating and reciprocating machinery; exact analysis of stresses produced by these and other dynamic forces in machine parts. Prerequisites: E.Mch. 12, M.E. 54.
- 553. FRICTION AND LUBRICATION (3) The hydrodynamic theory of lubrication and methods of applying it to bearing design, together with a survey of methods of testing lubricants.



555. AUTOMATIC CONTROL SYSTEMS (3) Advanced problems and techniques in the design of automatic control systems with emphasis on stability, controller design, and optimum performance. Prerequisite: M.E. 455.
557. MECHANISM SYNTHESIS (3) Design and analysis of mechanisms for specific motion and energy requirements; intermittent mechanisms. Prerequisite: M.E. 457.
580. INVESTIGATION PROJECTS (2-6) Special experimental studies or investigations in mechanical engineering, adapted to individual requirements.

## METALLURGY

AMOS J. SHALER, *Head of the Department*  
5 Mineral Sciences Building

The department offers studies leading to the M.S. and Ph.D. degrees. There is opportunity to specialize, both in research and in course work, in chemical metallurgy, physical metallurgy, mechanical metallurgy, or the science of metals. Minor work in any of these specializations is available for students majoring in another field.

The requirements for admission are a satisfactory B.S. degree in metallurgy, metallurgical engineering, chemistry, chemical engineering, physics, mechanical engineering, or engineering mechanics; or a satisfactory bachelor's degree in another field, provided it has included the equivalents of mathematics through integral calculus, 8 credits of physics, 12 credits of chemistry, 10 credits of other scientific, engineering, or mineral science fields, and 10 credits of metallurgy. Students who lack some of these requirements may be admitted but are required to take the prerequisite courses without being able to apply them toward an advanced degree.

### METALLURGY (METAL)

405. FERROUS METALLOGRAPHY (3)
406. NONFERROUS METALLOGRAPHY (3)
407. METALLURGICAL ENGINEERING I (3)
408. METALLURGICAL ENGINEERING II (3)
409. METALLURGICAL INVESTIGATIONS I (3)
410. METALLURGICAL INVESTIGATIONS II (3)
411. ADVANCED PHYSICAL METALLURGY (3)
412. EXPERIMENTAL METALLURGY (3)
413. ADVANCED CHEMICAL METALLURGY (3)
501. METALLURGICAL PROBLEMS (1-6 per semester) Independent study of special problems in metallurgy. Prerequisites: Metal. 411, 413.
502. SEMINAR IN METALLURGY (1-6) Conferences, reading, reports, and special lectures.
505. NUCLEAR REACTOR MATERIALS (3) Extractive metallurgy, alloy theory, transformations, physical properties, mechanical behavior, and corrosion of principal reactor materials; radiation damage; fuel element manufacture. Prerequisites: Metal. 59, E.Mch. 13.

## METALLURGY

515. CORROSION OF METALS (3) Phenomena and theories of metallic corrosion; principles of alloy selection for engineering and structural uses in corrosive environments. Prerequisites: Metal. 411, 413. *Mr. Read*
516. FLOW AND FRACTURE OF SOLIDS (3) Phenomenological and theoretical treatment of flow and fracture in solids. *Mr. Shaler*
518. CONSTITUTION OF METALLURGICAL SYSTEMS (3) Application of thermodynamic principles to study of heterogeneous equilibrium in alloy, slag, and slag-metal systems. Prerequisites: Metal. 411, 413. *Mr. Davis*
519. ADVANCED FERROUS METALLURGY (3) Physicochemical principles in the smelting and refining of iron and steel; slag control; solidification and primary forging of steel. Prerequisites: Metal. 411, 413. *Mr. Muan*
520. FOUNDRY METALLURGY (3) Principles of foundry metallurgy; application to foundry operations for various ferrous and nonferrous casting alloys. Prerequisites: Metal. 411, 413.
522. SOLID PHASE REACTIONS IN METALS (3) Mechanism and rate determining factors in solid phase reactions in metals; diffusion processes, nucleation theory, precipitations from solid solution, eutectoid decomposition and order-disorder phenomena. Prerequisites: Metal. 411, 413.
524. ADVANCED METAL WORKING (3) Elements of mathematical theory of plasticity; metal working processes; measurement of deformations in metal working; theory of metal working. Prerequisite: Metal. 516. *Mr. Shaler*
525. METAL FINISHING (3) Metallic coatings and their metallurgical properties; theories and problems of application, utilization, and evaluation. Prerequisites: Metal. 411, 413. *Mr. Read*

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in metallurgical studies are listed under Mineral Sciences in Part II of this bulletin.

## METEOROLOGY

HANS NEUBERGER, *Head of the Department*  
323 Mineral Industries Building

Graduate programs leading to the M.S. and Ph.D. degrees are offered. Candidates may specialize in aerosol and cloud physics, various phases of dynamic meteorology including turbulence and atmospheric circulation, atmospheric optics, macro- and microclimatology, agricultural meteorology, synoptic meteorology, or meteorological instrumentation.

Undergraduate requirements for admission include mathematics through differential equations, one year of college physics, and 12 credits in meteorology. Students may be admitted with deficiencies in some of the prerequisites but must make up such deficiencies before they are admitted to candidacy for a degree. This applies particularly to students with a strong background in mathematics, physics, or engineering.

## METEOROLOGY (METEO)

- 400. METEOROLOGY FOR TEACHERS (3)
- 411. SYNOPTIC METEOROLOGY I (3)
- 412. SYNOPTIC METEOROLOGY II (3)
- 418. INTRODUCTORY PHYSICS OF THE UPPER ATMOSPHERE (3)
- 431. SYNOPTIC METEOROLOGY LABORATORY I (3)
- 432. SYNOPTIC METEOROLOGY LABORATORY II (2-10)
- 433. ADVANCED SYNOPTIC ANALYTICAL TECHNIQUES (3)
- 443. PHYSICAL METEOROLOGY (3)
- 445. HYDROMETEOROLOGY (3)
- 450. APPLICATIONS OF STATISTICS TO METEOROLOGY (3)
- 451. DYNAMIC METEOROLOGY I (3)
- 452. DYNAMIC METEOROLOGY II (3)
- 461. THEORY OF METEOROLOGICAL INSTRUMENTS (3)
- 472. PHYSICAL AND DYNAMIC CLIMATOLOGY (3)
- 492. METEOROLOGICAL SEMINAR (2)
  
- 500. METEOROLOGICAL SEMINAR (1-3) Discussion of meteorological reports and papers; scientific outlook. Prerequisites: Meteo. 412, 451.
- 502. SELECTED TOPICS OF ADVANCED METEOROLOGY (2) Current problems in meteorology. Prerequisite: a minimum of 15 credits in meteorology.
- 503. ATMOSPHERIC TURBULENCE (3) Atmospheric diffusion, heat conduction, friction, and evaporation; statistical properties of turbulence.
- 504. ADVANCED DYNAMIC METEOROLOGY (3) Introduction to perturbation theory with application to gravitational and long waves; principles of dynamic-numerical forecast methods. Prerequisite: Meteo. 452.
- 505. BIOCLIMATOLOGY (2) Climatic phenomena in their relation to life. Prerequisite: Meteo. 472.
- 506. ADVANCED METEOROLOGICAL ANALYSIS (2-6) Physical analysis of atmospheric phenomena; synoptic analysis of weather phenomena for advanced students. Prerequisite: Meteo. 412.
- 507. DYNAMIC OCEANOGRAPHY (2) Physical properties of sea water; heat balance of the oceans; theory and observations of ocean currents, waves, and tides.
- 508. PHYSICS OF THE UPPER ATMOSPHERE (2) Temperature distribution, composition, and electrical characteristics of the upper atmosphere; theories of aurora and light of the night sky.
- 509. THEORETICAL CLIMATOLOGY (2) Theory of latitudinal, annual, and diurnal temperature changes; theories of climatic changes; microclimate.
- 510. CLOUD PHYSICS (2) Current theories on phase changes in clouds and mechanisms responsible for precipitation; techniques of cloud modification and control.

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in meteorological studies are listed under Mineral Sciences in Part II of this bulletin.



## MINERAL ECONOMICS

JOHN D. RIDGE, *Head of the Department*  
207 Mineral Sciences Building

The department offers graduate work leading to the M.S. and Ph.D. degrees. A student may specialize in the economics of exploration for, and the extraction, beneficiation, and utilization of, the ferrous and nonferrous metals, the nonmetals, the fuels, and ground water. Work is also offered in property evaluation, analysis of mineral data, and the influence of technological advances on mineral economics.

The requirements for admission are 24 credits in chemistry, physics, and mathematics; 12 in geology, mineralogy, and/or the biological sciences; 9 in mineral economics, economics, commerce, and/or geography; and 6 in mining, metallurgy, petroleum engineering, ceramics, and/or industrial engineering.

Students having a deficiency of 9 credits or fewer in this total of 51 may be admitted as regular graduate students but will be required to make up such deficiencies without the credits being applicable toward the advanced degree.

### MINERAL ECONOMICS (MN EC)

- 400. SEMINAR (1)
- 453. NONMETALLIC MINERALS (3)
- 463. MINERAL ECONOMY OF THE U.S.S.R. (3)
- 483. THE METALS AND THEIR ORES (3)
- 484. THE SOLID FUELS (3)
- 486. PETROLEUM AND NATURAL GAS ECONOMICS (3)
- 490. MINERAL VALUATION (3)
- 491. ANALYSIS OF MINERAL DATA (2)
  
- 500. ADVANCED PRINCIPLES OF MINERAL ECONOMICS (3-6) Economic history of mineral industries, research methods, economics of mineral exploitation and utilization, mineral policy.
- 501. RESEARCH IN MINERAL ECONOMICS (3-6) Investigation in specialized fields of research in mineral economics. Prerequisite: 3 credits in Mn.Ec. 500.
- 502. TECHNOLOGIC INFLUENCES (3-9) Relationship of technologic advancements to economic development of the mineral industries. Prerequisite: 3 credits in Mn.Ec. 500.
- 505. PROBLEMS OF MINERAL ECONOMICS (3-12) Determination of basic technologic-economic patterns of selected mineral industries. Prerequisite: 3 credits in Mn.Ec. 500.

## MINERAL PREPARATION

H. BEECHER CHARMBURY, *Head of the Department*  
4 Mineral Industries Building

Areas in which students may specialize in this department include the fundamentals of gravity, electrical, and chemical methods of beneficiating natural mineral deposits. Graduate work may also be undertaken on the properties of specific minerals as they are related to beneficiation. The M.S. and Ph.D. degrees are offered.

## MINERAL PREPARATION

Graduates with a B.S. degree in such scientific fields as chemistry, physics, and mathematics, and in such engineering fields as mining, metallurgy, ceramics, fuel technology, and mechanical, electrical, and civil engineering are eligible for admission to an advanced degree program in mineral preparation. However, graduates in the above fields are required to take 6 credits of undergraduate courses in mineral preparation along with their graduate program.

### MINERAL PREPARATION (MN PR)

- 400. MINERAL PREPARATION SEMINAR (1)
- 403. FLOWSHEETS OF MINERAL PREPARATION PLANTS (3)
- 404. PLANT LAYOUT AND DESIGN (3)
- 410. COAL PREPARATION (3)
- 415. MINERAL PREPARATION TESTING (2)
- 416. UNIT OPERATIONS (3)
  
- 502. FROTH FLOTATION AND AGGLOMERATION (3) Intensive study of theory and applications of froth flotation and agglomeration. Prerequisite: Mn.Pr. 416. *Mr. Sun*
- 504. MINERAL PREPARATION RESEARCH (3-10) Research work on specific problems in mineral preparation. Prerequisite: Mn.Pr. 416 or 410. *Mr. Charmbury and Staff*
- 505. GRAVITY PROCESSES AND MISCELLANEOUS METHODS OF MINERAL PREPARATION (3) Intensive study of theory and applications of gravity, magnetic, electrostatic, centrifugal, and dense-media processes of mineral concentration. Prerequisite: Mn.Pr. 416. *Mr. Mitchell*
- 506. MINERAL PREPARATION PLANT DESIGN (3-10) Layout, design, and selection of equipment for specific mineral preparation plant projects. Prerequisite: Mn.Pr. 416. *Mr. Mitchell*

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in mineral preparation studies are listed under Mineral Sciences in Part II of this bulletin.

## MINERALOGY AND PETROLOGY

JOHN C. GRIFFITHS, *Head of the Department of Mineralogy*  
114 Mineral Sciences Building

Graduate instruction and research leading to the M.S. and Ph.D. degrees is offered. Areas of specialization include igneous, sedimentary, and metamorphic petrology, mineralogy, crystal chemistry, X-ray mineralogy, clay mineralogy, ore mineralogy, and applications of statistics in the earth sciences.

The general requirements for admission are mathematics through integral calculus, chemistry through quantitative analysis, 10 credits of general physics, 30 credits of geology, petrology, and mineralogy including microscopical petrography (i.e., an equivalent to Min. 483, acceptable to the faculty).

Additional specific requirements must be fulfilled in most areas of specialization. Deficiencies may, in most cases, be made up after admission.

## MINERALOGY AND PETROLOGY

### MINERALOGY (MIN)

460. OPTICAL MINERALOGY (3) *Mr. Wright*
483. PETROGRAPHY (4) *Messrs. Griffiths and Thornton*
500. OPTICAL CRYSTALLOGRAPHY OF MINERALS (3) Optical methods, microscopic techniques, and measurement of optical constants of crystals; theory and application of the universal stage. Prerequisite: Min. 460. *Mr. Wright*
- 501a. PETROLOGY (3-6) Microscopic study of rocks, emphasizing classification and genetic relationships. *Messrs. Krynine, Tuttle, and Griffiths*
502. MINERALOGICAL PROBLEMS (3) Original study of some limited mineralogical or petrological problems.
504. THEORETICAL MINERALOGY (3) Crystal chemistry and crystal physics applied to solid solution, polymorphism, crystal growth, and related phenomena. *Mr. Bates*
505. MINERALOGY SEMINAR (1-2) Reading, presentation, and discussion of literature dealing with various phases of theoretical mineralogy. Topics are selected to meet the interests of the majority of the students. *Messrs. Krynine, Tuttle, Bates, Griffiths, and Brindley*
- \*510. METAMORPHIC PETROLOGY (2-6) Detailed review of chemical, mineralogical, and structural changes that take place during metamorphism. Prerequisite: Min. 483. *Mr. Thornton*
511. SEDIMENTARY PETROLOGY (3-4) Composition, texture, structure, mass properties of sediments; dynamic processes in complex natural systems; sedimentary stages: weathering, erosion, transport, deposition, and lithification. Prerequisite: Min. 483. Concurrent: Min. 513. *Mr. Krynine*
512. SEDIMENTARY PETROLOGY, CONTINUED (2-4) Diastrophism and tectonic background of sedimentation; depositional loci; classification of sediments: quartzites, graywackes, arkoses; chemical sediments; paleogeography, paleoclimatology, oil finding. Prerequisite: Min. 511. Concurrent: Min. 514. *Mr. Krynine*
513. METHODS OF ANALYSIS OF SEDIMENTS (3) Principles and practices used in analyzing sedimentary rocks for size, shape, and accessory (heavy) minerals. Concurrent: Min. 511. *Mr. Griffiths*
514. APPLIED SEDIMENTOLOGY (3) Design and control in analysis of sedimentary rocks; application of these techniques to industrial problems. Concurrent: Min. 512. *Mr. Griffiths*
- †517. SEDIMENTS OF THE WORLD (1-9) Microscopic and field studies of representative American and foreign rock suites; correlation with paleogeographic, geotectonic, economic data. Prerequisites: Min. 512, 514. *Mr. Krynine*
- ‡518. LIMESTONES AND DOLOMITES (2-6) End member concept in the study of composition, texture, structure, field distribution, and origin of carbonates and cherts. Prerequisite: Min. 483. *Mr. Krynine*

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\* Credits to be arranged, 2-4 per semester.

† Credits to be arranged, 1-3 per semester.

‡ Credits to be arranged, 2-3 per semester.



## MINERALOGY AND PETROLOGY

- ‡519. OIL RESERVOIR PETROLOGY (2-6) Petrographic fundamentals controlling porosity, storage capacity, oil accumulation, effective permeability, fluid yield and retention, exploration and production methods. Prerequisites: Min. 512, 514, 516.  
*Messrs. Krynine and Griffiths*
520. STUDY OF ACCESSORY MINERALS (2-4) Detailed study of accessory (heavy) minerals; their significance in problems of provenance, petrogenesis, mineral stratigraphy, and paleogeography. Prerequisites: Min. 511, 512, 513, 514. *Mr. Griffiths*
521. COLOR IN MINERALS (1-2) Nature of light absorption as a function of chemical composition for solutions, glasses, and minerals. *Mr. Weyl*
524. INTRODUCTION TO SEDIMENTATION (3) Concurrent: Min. 483. *Mr. Krynine*
525. IGNEOUS PETROLOGY (2-6) Origin, distribution, and composition of igneous rocks. Prerequisites: Min. 483, 500, 527; G.G. 513. *Mr. Tuttle*
526. STATISTICAL PROBLEMS IN SEDIMENTARY GEOLOGY (3) Application of experimental design, sampling procedures, multiple regression and discriminant analysis in solving problems in sedimentary petrography. Prerequisites: Min. 514; Math. 410 or Agro. 545. *Mr. Griffiths*
527. IGNEOUS AND METAMORPHIC MINERALOGY (3) Structural and compositional variations of minerals in igneous and metamorphic rocks. *Mr. Smith*
530. (Cer.T. 530). STRUCTURE, PROPERTIES, AND OCCURRENCE OF CLAY MINERALS (2-5) Structure analysis and identification of clay minerals; mineral transformations and behavior; occurrence, genesis, and petrography of fine-grained sediments.  
*Messrs. Griffiths, Bates, and Brindley*

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in mineralogical studies are listed under Mineral Sciences in Part II of this bulletin.

## MINING ENGINEERING

HOWARD L. HARTMAN, *Head of the Department of Mining*  
305B Mineral Industries Building

Graduate work is offered leading to the M.S. and Ph.D. degrees. Research and graduate work are available in underground stress analysis, drilling and blasting, mined materials handling, electric power for mines, mathematical analysis of mine layouts, ventilation network studies, mine operations programming, mine safety trends, dust control, roof support methods, continuous mining, mine illumination, mine production and cost control, and mine property valuation.

At least a B.S. degree in mining or some related engineering field is required for admission to graduate work. Students may be required to schedule certain prerequisite courses without degree credit.

### MINING (MNG)

401. MINE PLANT ENGINEERING I (2)  
402. MINE PLANT ENGINEERING II (3)  
411. MINE INDUSTRIAL ENGINEERING (2)  
412. MINE MANAGEMENT AND SUPERVISION (2)  
422. MINE VENTILATION AND AIR CONDITIONING (3)

‡ Credits to be arranged, 2-3 per semester.

## MINING ENGINEERING

424. MINE SAFETY ENGINEERING (1)  
431. ROCK MECHANICS (2)  
451-452. ADVANCED MINING ENGINEERING I and II (1 each)  
490. SENIOR MINING SEMINAR (1)
513. MINE COST ANALYSIS (3) Nature of mining costs, their analysis and control: depreciation and depletion, capital and operating costs, budgets, records.
514. MINE OPERATIONS PLANNING (3) Scientific planning and layout of mining operations based on time studies, mathematical analysis, and proportionality of centroids of reserves. Prerequisites: Math. 44 or 45, Mng. 411.
525. DUST TECHNOLOGY (3) Physical and chemical properties of dusts; airborne dust determinations and analysis; dust control applicable to mills and mines. Prerequisite: Mng. 422.
526. MINE VENTILATION (3) Airflow in mine openings and its control; network solution by mathematics and computer; design of mine and industrial ventilation systems. Prerequisite: Mng. 422.
528. MINE AIR CONDITIONING (3) Thermodynamics of vapor mixtures; heat flow through rock; physiological effects of hot, humid environments; design of temperature-humidity control systems. Prerequisite: Mng. 422.
532. ROCK MECHANICS (3) Behavior of rock under static loading; underground stress instrumentation; experimental stress analysis; design of mine openings; theories of subsidence. Prerequisite: Mng. 431.
541. THEORY OF ROCK PENETRATION (3) Behavior of rock under dynamic loads intended to penetrate; basic energy relations; application of theory to drilling and other penetration. Prerequisites: Phys. 285, Mng. 31.
542. THEORY OF ROCK FRAGMENTATION (3) Behavior of rock under dynamic loads intended to fragment; physical chemistry of explosives; detonation; theory of blasting; design of drill rounds. Prerequisites: Phys. 285, Mng. 31.
580. MINING ENGINEERING RESEARCH (1-3 per semester) Supervised research on a specific problem involved in mining science or technology.
590. GRADUATE MINING SEMINAR (1 per semester) Preparation and presentation of formal papers on problems of an advanced nature in mining engineering. Required each semester in residence.

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in mining studies are listed under Mineral Sciences in Part II of this bulletin.*

## MUSIC

HUMMEL FISHBURN, *Head of the Department*  
217 Carnegie Building

Graduate work in music leads to the M.A. degree. Students may emphasize one of the following areas, or may elect a program including work in all of them: theory, performance, music literature, and creative music. The minor is chosen from the liberal arts. Admission to this graduate program requires completion of a recognized music curriculum.

## MUSIC (MUSIC)

407. PIANO LITERATURE (3)  
 408. VOCAL LITERATURE (3)  
 410. MUSIC OF THE 20TH CENTURY (3)  
 411. LITERATURE OF THE VIOLIN (3)  
 \*429. SINGER'S STYLE AND INTERPRETATION (3) Fee \$50.  
 456. ELEMENTARY COUNTERPOINT (3)  
 459. MODERN INSTRUMENTAL ARRANGING (3)  
 466. ADVANCED CONDUCTING (3)
- \*503. ADVANCED STRINGED INSTRUMENTS (3) Study, repertoire building, and recital performance. Fee \$50.
- \*511. ADVANCED PIANO (3) Piano literature of all periods for public performance. Fee \$50.
- \*531. ADVANCED ORGAN (3) Study, repertoire building, and recital performance. Prerequisite: 4 credits of Music 31 and/or 38. Fee \$60.
543. MODERN HARMONY (3) Harmonic writing based on 20th century practices with attention to traditional idioms that serve as foundation.
557. SYMPHONIC STRUCTURE (3) Survey of the evolution and application of the forms used in symphony, sonata, concerto, string quartet, and related works. Prerequisite: Music 57.
- \*558. FREE COMPOSITION (3) Composition: vocal and instrumental, standard or modern idioms. Prerequisite: 18 credits in harmony, counterpoint, and piano.
563. FREE ARRANGING (3) Correct procedure in arranging for vocal and instrumental ensembles; practical exercises in quartets, glee clubs, and choruses; small instrumental groups, band, and orchestra. Prerequisite: 18 credits in harmony, including 3 of orchestration.
567. THE LITERATURE OF THE ORCHESTRA (3) The suite, symphony, tone poem, and overture from the point of view of appreciation, form, and orchestration. Prerequisites: Music 6 and theoretical knowledge of the key instruments of the orchestra.

## MUSIC EDUCATION

HUMMEL FISHBURN, *Head of the Department*  
 217 Carnegie Building

The department offers graduate work leading to the M.Ed. and D.Ed. degrees with a major in music education and a minor in music. The program for the master's degree includes some courses in general education, and the program for the doctor's degree includes considerable work in general education.

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\* May be repeated for a total of 12 credits.



## MUSIC EDUCATION

At the doctoral level emphasis may be upon work in vocal, instrumental, or theoretical music in elementary, secondary, or college teaching; but the degree requires work in all of these fields. Admission to the graduate program requires completion of a recognized music education curriculum.

### MUSIC EDUCATION (MU ED)

- 401. MUSIC IN THE RURAL AREA (3)
- 462. PEDAGOGY OF THEORY (3)
- 468. THE TEACHING OF PIANO (3)
- 469. BAND AND ORCHESTRA TECHNIQUE (3)
- 470. CHORAL TECHNIQUE (3)
- 475, 475X. OBJECTIVES AND PROBLEMS IN ELEMENTARY MUSIC EDUCATION (3)
- 480. CHORAL PROGRAM IN THE SECONDARY SCHOOL (3)
  
- 500. MUSIC EDUCATION SEMINAR (3-6) Problems of various phases of music education, both instrumental and vocal; research and literature dealing with these problems.
  
- 569. PRESENT-DAY TRENDS IN INSTRUMENTAL MUSIC (3) New methods and materials for band, orchestra, and ensembles.
  
- 571. VOCAL PEDAGOGY (3) Detailed study of vocal problems met in public schools, elementary through high school; vocal class pedagogy and literature; daily voice training. Prerequisites: Mu.Ed. 48, teaching experience.
  
- 572. INSTRUMENTAL PEDAGOGY (3-6) Research problems in band and orchestra. Prerequisite: Mu.Ed. 54 or practical experience.
  
- 573. THE MATERIALS OF APPRECIATION (3) Methods and materials for development of music appreciation in elementary and secondary schools. Prerequisites: Music 5, teaching experience.
  
- 574a,b. PRESENT-DAY TRENDS IN MUSIC EDUCATION (3-6) Present-day music education materials and methods (elementary and secondary levels) in relation to modern educational philosophy; emphasis upon practical problems presented by members of the class. Prerequisites: Mu.Ed. 48, teaching experience.
  
- 575. THE JUNIOR HIGH SCHOOL MUSIC CURRICULUM (3) Instructional materials, procedures, curricular and extracurricular activities, integration with other subjects.
  
- 576. MUSIC SUPERVISION (3) Current educational procedures in training music supervisors.
  
- 580. FIELD PROJECTS IN JUNIOR AND SENIOR HIGH SCHOOL MUSIC (3) Curricular problems to be carried on under actual school conditions; individual work under supervision. Prerequisites: teaching experience, 30 credits of graduate study.
  
- 594. PEDAGOGY OF EAR TRAINING (3) Materials and methods for training the listener to grasp, understand, and write what is heard from melody to four-part harmony. Prerequisite: 12 credits in ear training and/or harmony.

## NUCLEAR ENGINEERING

WARREN W. MILLER, *Chairman of the Committee on Nuclear Engineering*  
206 Walker Laboratory

The M.S. and M.Eng. degrees are offered in nuclear engineering. Admission requires a bachelor's degree in engineering or in the physical sciences. Students who have not had appropriate undergraduate courses in nuclear physics and partial differential equations will be required to schedule them without graduate credit. A student may specialize in reactor analysis, nuclear materials, or reactor instrumentation and control.

### PHYSICAL SCIENCE (PH SC)

501. SEMINAR IN NUCLEAR SCIENCE AND ENGINEERING (0)

## PETROLEUM AND NATURAL GAS ENGINEERING

ROBERT L. SLOBOD

*Head of the Department of Petroleum and Natural Gas*  
26 Mineral Industries Building

The M.S. and Ph.D. degrees are offered with a major in petroleum and natural gas engineering. Areas of specialization include experimental and theoretical studies of water flooding and the newer methods for displacing oil from porous media, methods for calculating reservoir performance, scaled laboratory studies of reservoir phenomena, and drilling and well completion problems.

Students who expect to enter graduate study in this field with a degree in another curriculum should present 20 credits of chemistry and physics, 6 of geology, 15 of engineering science, and credit for mathematics through integral calculus. A limited number of deficiencies may be made up after admission.

Certain closely related courses outside the department may be counted as petroleum and natural gas credits toward the degree.

### PETROLEUM AND NATURAL GAS (P N G)

421. RESERVOIR ENGINEERING (3)

481. NATURAL GAS AND GASOLINE PLANTS (2)

485. SECONDARY RECOVERY (3)

490. ADVANCED CORE TESTING (3)

500. PETROLEUM AND NATURAL GAS ENGINEERING PROBLEMS (3-9 per semester)

501. ENERGETICS OF PETROLEUM ENGINEERING (3) Applications of thermodynamics to special problems in production of petroleum and natural gas.

502. PETROLEUM AND NATURAL GAS ENGINEERING SEMINAR (3-9) Intensive study of one or several phases of petroleum engineering.

## PETROLEUM AND NATURAL GAS ENGINEERING

503. THE FLOW OF HOMOGENEOUS FLUIDS THROUGH POROUS MEDIA (3) Flow and pressure distributions for various geometric patterns for steady and unsteady states. Prerequisite: Math. 431.
504. WATER FLOODING (3-6) Continuation of P.N.G. 485 with emphasis on special problems. Prerequisite: Chem. 460.
506. ADVANCED PETROLEUM ENGINEERING (5) Advanced problems in petroleum and natural gas production. Prerequisites: Chem. 461, P.N.G. 310.
507. CONDENSATE FIELDS (2) Retrograde condensation phenomenon of hydrocarbon mixtures at high pressures; literature on condensate fields; production methods and equipment design: casing heads, compressors, separators, stabilizers; safety measures. Prerequisite: P.N.G. 501.
508. COLLOIDAL BEHAVIOR OF INDUSTRIAL CLAYS, MUDS, AND SLIMES (2-3) Principles of colloidal activity applied to control of properties of clay slips, drilling fluids, and similar suspensions. (In co-operation with the Ceramic Technology staff.) Prerequisite: Chem. 461.
509. ADVANCED PETROLEUM ENGINEERING DESIGN (2) Continuation of P.N.G. 320. Projects in selection of engineering materials for casing programs, drilling rigs; production, treatment, stabilization, and transportation of crude oils. Prerequisite: P.N.G. 320.

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in petroleum and natural gas studies are listed under Mineral Sciences in Part II of this bulletin.*

## PHILOSOPHY

ERNEST H. FREUND, *Head of the Department*  
217 Sparks Building

The department offers graduate work leading to the M.A. degree. A student may concentrate on history of philosophy, logic and scientific methods, or value theory. Undergraduate preparation should include a major in philosophy, but a strong minor may also be acceptable.

### PHILOSOPHY (PHIL)

401. RELIGIOUS PHILOSOPHY OF THE GREAT REFORMERS (3)
- 404X. ADVANCED HISTORY OF PHILOSOPHY (3)
406. MEDIEVAL PHILOSOPHY (3)
410. STUDIES IN GREEK PHILOSOPHY (3-6)
411. STUDIES IN MODERN PHILOSOPHY (3-6)
414. AESTHETIC THEORY (3)
418. RECENT AND CONTEMPORARY PHILOSOPHY (3)
419. PHILOSOPHICAL BACKGROUNDS OF AMERICAN THOUGHT (3)
425. PHILOSOPHY OF LAW (3)
426. METAPHYSICS (3)
427. ADVANCED ETHICS (3)
428. (Math. 428). LOGICAL THEORY (3)



- 429. SEMANTICS: PHILOSOPHY OF LANGUAGE AND SYMBOLISM (3)
- 430. PHILOSOPHICAL PROBLEMS (3-6)
- 450. TYPES OF PHILOSOPHY (3)
- 500. ETHICS: HISTORICAL AND SYSTEMATIC (2-6) Critical study of some phase of ethical theory, or of some period of the history of ethics.
- 503. LOGIC (3) The logical basis of mathematics and its ultimate nature.
- 504. SOCIAL AND POLITICAL PHILOSOPHY (3) Critical study of basic problems in their historical and functional setting.
- 505. IDEALS OF WESTERN CIVILIZATION (3) Analysis of contemporary ideals in terms of their Graeco-Judean bases.
- 507. SEMINAR IN ANCIENT AND MEDIEVAL PHILOSOPHY (3-6) Study of one or more important men or movements in ancient or medieval philosophy.
- 508. SEMINAR IN MODERN PHILOSOPHY (3-6) Men and movements in philosophy from the Renaissance through the 19th century.
- 509. SEMINAR IN CONTEMPORARY PHILOSOPHY (3-6) Men and movements in 20th century philosophy.
- 510. CLASSICS OF SCIENTIFIC METHOD (3-6) Actual reasoning and procedures of historical masters of scientific methods.
- 511. PRINCIPLES OF EXPERIMENTAL INFERENCE (3-6) Science as controlled inquiry; types of scientific procedures in formal, physical, and sociocultural science.

## PHYSICAL EDUCATION

JOHN D. LAWTHER

*Associate Dean of the College of Physical Education and Athletics*  
246 Recreation Building

Programs are offered leading to the M.Ed., M.S., D.Ed., and Ph.D. degrees. Areas of specialization include: (1) history, philosophy, and principles; (2) applied science (physiology of exercise, kinesiology, body mechanics); (3) organization and administration; (4) objectives, programs, methods, and evaluation; (5) adaptives and correctives; (6) health; and (7) athletics, intramural and interschool. The master's candidate is expected to acquire a basic minimum of knowledge in each of these areas with little specialization except for his thesis or problem. The doctoral candidate is expected to focus on one area during his final year of graduate work.

The requirements for admission to the M.Ed. program are 24 semester hours in professional health and physical education and 24 in education and psychology, including general psychology, educational psychology, principles and methods of teaching, education electives, and practice teaching.

The requirements for admission to the M.S. program are 36 semester hours in professional health and physical education and 18 in education and psychology. An excellent background in the biological and physical sciences may satisfy up to half of the requirement in professional health and physical education.

## PHYSICAL EDUCATION

### PHYSICAL EDUCATION (PH ED)

424. MODERN TRENDS IN HEALTH AND PHYSICAL EDUCATION, RECREATION EDUCATION, AND ATHLETICS (3)
441. ADVANCED COACHING OF ATHLETICS FOR MEN (1-11)
- |                                    |                               |
|------------------------------------|-------------------------------|
| <i>Unit A. Basketball (1)</i>      | <i>Unit G. Swimming (1)</i>   |
| <i>Unit B. Football (1)</i>        | <i>Unit H. Gymnastics (1)</i> |
| <i>Unit C. Track and Field (1)</i> | <i>Unit I. Boxing (1)</i>     |
| <i>Unit D. Baseball (1)</i>        | <i>Unit J. Lacrosse (1)</i>   |
| <i>Unit E. Wrestling (1)</i>       | <i>Unit K. Fencing (1)</i>    |
| <i>Unit F. Soccer (1)</i>          |                               |
449. ADVANCED TEACHING OF SPORTS AND RHYTHMICS (1-11)
- |                                                         |                                                                              |
|---------------------------------------------------------|------------------------------------------------------------------------------|
| <i>Unit A. Soccer and Speedball (1)</i>                 | <i>Unit H. Early American Country<br/>Dancing and Social Dancing<br/>(1)</i> |
| <i>Unit B. Basketball (1)</i>                           |                                                                              |
| <i>Unit C. Field Hockey (1)</i>                         | <i>Unit I. Tennis (1)</i>                                                    |
| <i>Unit D. Archery (1)</i>                              | <i>Unit J. Badminton (1)</i>                                                 |
| <i>Unit E. Swimming (1)</i>                             | <i>Unit K. Golf (1)</i>                                                      |
| <i>Unit F. Rhythmics for Children (1)</i>               |                                                                              |
| <i>Unit G. Modern Dance and Accom-<br/>paniment (1)</i> |                                                                              |
- 452, 452X. ANALYSIS OF PHYSICAL EDUCATION ACTIVITIES FOR THE ELEMENTARY SCHOOL (3)
- 453, 453X. ANALYSIS OF PHYSICAL EDUCATION ACTIVITIES FOR THE HIGH SCHOOL (3)
454. THE NATURAL PROGRAM OF PHYSICAL EDUCATION ACTIVITIES, APPLIED (3)
455. SCIENTIFIC METHOD IN HEALTH AND PHYSICAL EDUCATION (3)
460. METHODS AND PRINCIPLES OF ATHLETIC COACHING (3)
480. ADVANCED ANATOMY AND PHYSIOLOGY, APPLIED (3)
- 482, 482X. POSTURE EDUCATION IN THE SCHOOLS (3)
489. INTRAMURAL ATHLETICS (3)
490. INTRODUCTION TO TESTS AND MEASUREMENTS IN HEALTH AND PHYSICAL EDUCATION (3)
491. ORGANIZATION AND ADMINISTRATION OF HEALTH AND PHYSICAL EDUCATION IN SCHOOLS (3)
500. PROBLEM IN PHYSICAL EDUCATION (3) Prerequisite: Ph.Ed. 455.
522. ORGANIZATION AND ADMINISTRATION OF PHYSICAL EDUCATION IN COLLEGES AND UNIVERSITIES (3) Administration of physical education in college; credits, schedules, excuses, records, reports, budgets, classification, tests, staff, and facilities. Prerequisite: Ph.Ed. 491.
523. ADMINISTRATION OF COLLEGE ATHLETICS (3) Eligibility, schedules, managerial systems, relationships of athletics to the physical education program and to education in general. Prerequisite: Ph.Ed. 491.
526. ATHLETIC PROBLEMS IN SCHOOLS (3) Practical problems which result from administration of athletics in schools. Reports on some aspects of athletics required. Prerequisite: Ph.Ed. 460.
528. PROFESSIONAL EDUCATION OF TEACHERS OF HEALTH AND PHYSICAL EDUCATION (3) Health and physical education surveys, publicity, sociability and personality tests, legislation, state certification, standards for facilities and equipment, in-service, follow-up, and teacher-community problems. Prerequisite: Ph.Ed. 491.

## PHYSICAL EDUCATION

529. SUPERVISION OF PHYSICAL EDUCATION IN SCHOOLS (3) Methods and policies of the school supervisor of physical education; conferences, planning and presenting the program, evaluating results, improving teachers-in-service, supervision of the classroom teacher. Prerequisite: Ph.Ed. 491.
530. RESEARCH TECHNIQUES IN HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (3) Prerequisite: Ph.Ed. 490.
531. RESEARCH IN HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (3) Prerequisite: Ph.Ed. 530.
532. TESTS AND MEASUREMENTS IN PHYSICAL EDUCATION (3) Critical study of tests and measurements available in physical education; methods of constructing and evaluating new tests and measurements. Prerequisite: Ph.Ed. 490.
534. STUDIES IN CURRICULUM CONSTRUCTION IN PHYSICAL EDUCATION (3) Principles and methods of curriculum building in physical education; different psychological and educational points of view, organizing a course of study committee, making units of instruction. Prerequisite: Ph.Ed. 454.
535. MODERN FOREIGN SYSTEMS OF PHYSICAL EDUCATION (3) Comparative analysis of national and local programs and systems of physical education in foreign countries. Prerequisites: Ph.Ed. 534, 595.
536. SCIENTIFIC METHODS IN ATHLETIC COACHING (3) Unusual techniques in athletic coaching which are not commonly recognized and used; advanced skills and strategy in coaching major sports. Prerequisite: Ph.D. 460.
550. SEMINAR IN HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (1-6) Open only to students preparing approved theses.
555. RELATIONSHIPS OF PHYSICAL EDUCATION TO THE EXACT SCIENCES (3)
560. ADMINISTRATIVE PROBLEMS OF PHYSICAL EDUCATION IN SCHOOLS (3) Solutions to problems emerging from the administration of physical education in schools, fitting physical education into the school's schedule, awards and budgets. Prerequisite: Ph.Ed. 491.
581. PROBLEMS IN BODY MECHANICS (3) Certain aspects of human motion and body segmental alignment; analysis of human gait, and the dynamic adaptation of the spine, thorax, and pelvis to external physical forces. Prerequisite: Hl.Ed. 244, Ph.Ed. 399.
595. PHILOSOPHY OF HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (3) Prerequisite: Hl.Ed. 453 or Ph.Ed. 491 or Rc.Ed. 465.

## PHYSICAL SCIENCE

HENRY W. KNERR

*Chairman of the Committee on Physical Science*  
104 Willard Building

The M.Ed. degree is offered with a major in physical science. The program, which is designed to meet the needs of secondary school science teachers, consists of at least 24 credits chosen from chemistry, geology, mathematics, and physics and a minor of



at least 6 credits in basic education. A candidate is expected to complete at least one course in each of the four sciences and at least 12 credits in one of them. Appropriate courses are regularly offered in the summer, but are rarely available during the academic year.

As a minimum requirement for admission a student is expected to have had 10 credits in chemistry, 8 credits in physics, mathematics through trigonometry, and 27 credits in education, including educational psychology and practice teaching.

## PHYSICS

JOHN A. SAUER, *Head of the Department*  
101 Osmond Laboratory

The Department of Physics offers graduate work leading to the M.S. and Ph.D. degrees. Graduate instruction and research opportunities are available in visible and infrared spectroscopy, crystal structure, solid state, field emission, acoustics, high-pressure physics, biophysics, electronics, shock waves, low-temperature physics, nuclear physics, physics of high polymers, and various phases of theoretical physics.

A bachelor's degree in physics or an allied field is required for admission. Students who lack some of the usual upper-class undergraduate courses in physics may be requested to take additional course work without degree credit.

### PHYSICS (PHYS)

- 400. INTERMEDIATE ELECTRICITY AND MAGNETISM (4)
- 402. ELECTRONICS (4)
- 404. ELECTRONIC MEASUREMENTS (2-4)
- 406. NUCLEAR PHYSICS (3)
- 411. THEORETICAL MECHANICS (3)
- 412, 412X. THEORY OF THE SOLID STATE (3)
- 417. THE TEACHING OF PHYSICS (3)
- 420. INTERMEDIATE HEAT (3)
- 433. MECHANICS AND FLUID PHYSICS FOR TEACHERS (3)
- 435. ELECTRICITY AND MAGNETISM FOR TEACHERS (3)
- 436. OPTICS FOR TEACHERS (3)
- 437. HEAT, WAVE MOTION, AND SOUND FOR TEACHERS (3)
- 439. ELEMENTARY SURVEY OF MODERN PHYSICS FOR TEACHERS (3)
- 441. DEMONSTRATION EXPERIMENTS FOR TEACHERS (3)
- 443. INTERMEDIATE ACOUSTICS (3)
- 444. MEASUREMENTS IN ACOUSTICS (2)
- 454, 454X. ATOMIC AND NUCLEAR PHYSICS (3)
- 456. ATOMIC AND NUCLEAR PHYSICS (3)
- 457. EXPERIMENTAL ATOMIC PHYSICS (2)
- 458. INTERMEDIATE OPTICS (4)
- 461. THEORETICAL MECHANICS (3)
- 467. INTERMEDIATE ELECTRICITY AND MAGNETISM (3)
- 470. SPECIAL TOPICS (1-9)
- 473-474. BIOPHYSICS (3 each)
- 477. X-RAY ANALYSIS OF SOLIDS AND LIQUIDS (3)

507. THERMODYNAMICS AND KINETIC THEORY (3) Classical and modern thermodynamics; introduction to statistical mechanics.
509. PHYSICS SEMINAR (1-3 per semester) Topics from current research.
- 512-513. SOLID STATE PHYSICS (3 each) Analytical treatment of physical properties of solids: crystal structure, X-ray diffraction, lattice vibrations, paramagnetism, ferromagnetism, ferroelectricity; electron theory of metals, semi-conductors. Prerequisite: Phys. 530.
517. STATISTICAL MECHANICS (3) Classical and quantum statistics, theory of ensembles, degenerate gases, applications to low temperature effects and co-operative phenomena. Prerequisites: Phys. 507, 561.
521. CRYSTAL STRUCTURE (3) Crystal symmetry, X-ray scattering, theory and techniques of crystal structure determination.
522. ADVANCED CRYSTAL ANALYSIS (3) Phase-determining methods in crystal analysis.
530. THEORETICAL MECHANICS (4) Newtonian mechanics; Lagrange's equations, Hamilton's principle; Hamilton's equations; coupled systems; waves in strings, central field problem; rigid bodies; elasticity; hydrodynamics.
532. ADVANCED THEORETICAL MECHANICS (3) Least action principle; canonical transformation; Lagrange and Poisson brackets; Hamilton-Jacobi equations; classical theory of fields. Prerequisite: Phys. 530.
533. THEORETICAL ACOUSTICS (3) Vibrating systems; transmission of disturbances through elastic and visco-elastic media. Prerequisite: Phys. 530.
- 553-554. NUCLEAR PHYSICS (3 each) Discussion and theoretical interpretation of basic experiments involving atomic nuclei and nuclear radiations. Prerequisite: Phys. 562.
557. ELECTRICITY AND MAGNETISM (3) Electro- and magnetostatics, Maxwell's equations, boundary value problems, electric and magnetic properties of material media.
558. ADVANCED ELECTRICITY AND MAGNETISM (3) Energy and momentum in the field, radiation theory, classical relativistic electron theory. Prerequisite: Phys. 557.
560. RESEARCH PROBLEMS (1-18) Introduction to research through individual assignments.
- 561-562. QUANTUM MECHANICS (3 each) The basic theory of wave and matrix mechanics, approximation methods, applications. Prerequisite: Phys. 530.
565. REACTOR ANALYSIS (4) Physical principles and mathematical methods of reactor analysis. Prerequisite: Phys. 406.
566. REACTOR ANALYSIS (3) Continuation of Phys. 565. Prerequisite: Phys. 565.
571. ATOMIC PHYSICS (3) Experimental basis of modern physics; atomic spectra and structure, nuclear phenomena.

## PHYSICS

572. **SELECTED TOPICS IN SPECTROSCOPY (3)** Atomic and molecular spectra, experimental methods and theoretical analyses.
575. **SPECIAL TOPICS (1-3 per semester)** Theoretical studies in any field of modern physics with or without associated experimental work. Prerequisite: Phys. 456.

## PLANT PATHOLOGY

HENRY W. POPP

*Head of the Department of Botany and Plant Pathology*  
206 Buckhout Laboratory

The M.S. and Ph.D. degrees are offered in this field. The student may specialize in the study of plant diseases caused by fungi, bacteria, or viruses, and/or in their control, especially by plant breeding or by chemical means.

For admission a student must present at least 27 credits in botany, plant pathology, and biological science, of which not more than 6 may be in biological science. As many as 6 credits may be made up as undergraduate deficiencies after the candidate has been admitted to the Graduate School.

Courses in plant pathology are listed under botany. See especially Bot. 408, 412, 419, 421, 428, 429, 501, 509, 515, 519, 520, 521, 522, 523, 526, 529, 530, and 531.

## POLITICAL SCIENCE

M. NELSON McGEARY, *Head of the Department*  
120 Sparks Building

The M.A. and Ph.D. degrees are offered in this field. Students may specialize in American government, political theory, international relations, or comparative government. A Master of Public Administration degree is also offered in a special program built around Pl.Sc. 560, 561, and 562.

For admission to graduate work students should present 12 to 15 hours of undergraduate work in the field, or its equivalent.

### POLITICAL SCIENCE (PL SC)

- |                                                      |                |
|------------------------------------------------------|----------------|
| 401. POLITICAL BEHAVIOR (3)                          | Mr. Sorauf     |
| 411. AMERICAN POLITICAL THEORY (3)                   | Mr. Riemer     |
| 413. GOVERNMENT AND POLITICS OF THE SOVIET UNION (3) | Mr. Atwater    |
| 414. FOREIGN POLICY OF THE SOVIET UNION (3)          | Mr. Aspaturian |
| 415. INTERNATIONAL ORGANIZATION (3)                  | Mr. Aspaturian |
| 416. INTERNATIONAL LAW (3)                           | Mr. Aspaturian |
| 417. MUNICIPAL GOVERNMENT (3)                        | Mr. Corter     |
| 419. PUBLIC ADMINISTRATION (3)                       | Mr. McGeary    |
| 421. MODERN POLITICAL THEORY (3)                     | Mr. Riemer     |
| 424. STATE GOVERNMENT IN THE UNITED STATES (3)       |                |
| 426. POLITICAL PARTIES (3)                           | Miss Silva     |
| 427. PUBLIC OPINION AND PROPAGANDA (3)               | Miss Silva     |



## POLITICAL SCIENCE

- |                                                                       |                                              |
|-----------------------------------------------------------------------|----------------------------------------------|
| 428. PENNSYLVANIA LOCAL GOVERNMENT (3)                                | <i>Mr. Corter</i>                            |
| 429. PENNSYLVANIA LOCAL ADMINISTRATION (3)                            | <i>Mr. Corter</i>                            |
| 431. ANCIENT AND MEDIEVAL POLITICAL THEORIES (3)                      | <i>Mr. Riemer</i>                            |
| 432. CURRENT POLITICAL TRENDS AND PROBLEMS IN THE UNITED STATES (3-9) | <i>Messrs. Riemer and Sorauf, Miss Silva</i> |
| 433. AMERICAN LABOR LAW (3)                                           | <i>Mr. Brewster</i>                          |
| 442. AMERICAN FOREIGN POLICY (3)                                      | <i>Mr. Atwater</i>                           |
| 444. GOVERNMENT REGULATION (3)                                        | <i>Mr. Ferguson</i>                          |
| 445. ADMINISTRATIVE LAW (3)                                           | <i>Mr. Brewster</i>                          |
| 446. JUDICIAL SYSTEMS (3)                                             | <i>Mr. Law</i>                               |
| 451. COMPARATIVE GOVERNMENT (3)                                       |                                              |
| 456. GOVERNMENTS AND FOREIGN POLICIES OF LATIN AMERICA (3)            | <i>Mr. Law</i>                               |
| 458. GOVERNMENTS AND FOREIGN POLICIES OF THE FAR EAST (3)             | <i>Mr. Aspaturian</i>                        |
| 499X. FOREIGN STUDY IN GOVERNMENT (2-6)                               |                                              |
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- |                                                                                                                                                                                                                      |                                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| 500. SEMINAR IN POLITICAL SCIENCE (3-12) Subject to be announced.                                                                                                                                                    | <i>Mr. Brewster</i>            |
| 505. SEMINAR IN ADVANCED AMERICAN GOVERNMENT (3-12)                                                                                                                                                                  |                                |
| 508. RESEARCH IN PUBLIC ADMINISTRATION (3-12)                                                                                                                                                                        | <i>Mr. McGeary</i>             |
| 509. RESEARCH TECHNIQUES IN POLITICAL SCIENCE (3)                                                                                                                                                                    | <i>Miss Silva</i>              |
| 510. POLITICAL AND ADMINISTRATIVE PROBLEMS IN PENNSYLVANIA (3-6)                                                                                                                                                     | <i>Mr. McGeary</i>             |
| 512. COMPARATIVE GOVERNMENT (3-12)                                                                                                                                                                                   | <i>Mr. Atwater, Miss Silva</i> |
| 515. INTERNATIONAL RELATIONS (3-6)                                                                                                                                                                                   | <i>Mr. Atwater</i>             |
| 517. INTERNATIONAL ORGANIZATION (3-6)                                                                                                                                                                                | <i>Mr. Aspaturian</i>          |
| 519. PUBLIC ADMINISTRATION (3-6)                                                                                                                                                                                     | <i>Mr. McGeary</i>             |
| 521. POLITICAL THEORY (3-6)                                                                                                                                                                                          | <i>Mr. Riemer</i>              |
| 535. GOVERNMENT REGULATION (3-6)                                                                                                                                                                                     |                                |
| 560. PUBLIC MANAGEMENT I (15) Organization, management, personnel, budgeting, accounting, and other fiscal procedures in government at all levels.                                                                   |                                |
| 561. PUBLIC MANAGEMENT II (15) Administrative law, communications and report writing, statistics, public relations, public works administration, and planning in government at all levels. Prerequisite: Pl.Sc. 560. |                                |
| 562. PUBLIC MANAGEMENT III (6) Supervised internship and report. Prerequisite: Pl.Sc. 561.                                                                                                                           |                                |

## POULTRY HUSBANDRY

ARTHUR J. G. MAW, *Head of the Department*  
103 Weaver Building

Graduate study programs lead to the M.S. and Ph.D. degrees in the following areas of specialization: poultry nutrition, poultry management, poultry products, poultry breeding, or animal behavior. In each area the program consists of a joint

## POULTRY HUSBANDRY

major between the Department of Poultry Husbandry and one or more basic science departments. Admission requirements vary according to the area of specialization. Students with undergraduate majors in the basic sciences may qualify.

Excellent facilities are available for research in production, processing, and preservation of market eggs and dressed poultry, and in chick and poult nutrition. A specially designed and equipped Solar Laying House also provides facilities for investigation of production and behavioral problems encountered in large, concentrated populations of layers.

### POULTRY HUSBANDRY (P H)

401. (Psy. 401, Zool. 401). ANIMAL BEHAVIOR (3) *Mr. Hale*  
412. POULTRY BREEDING (3) *Mr. Maw*
502. ADVANCED POULTRY NUTRITION (2-4) Prerequisite: P.H. 3. *Mr. Murphy*  
503. ADVANCED POULTRY FARM MANAGEMENT (2-4) Prerequisite: P.H. 8. *Mr. Bressler*
504. ADVANCED MARKET POULTRY AND EGGS (2-4) Prerequisites: P.H. 1, 7; Ag.Ec. 33 or 2 additional credits in poultry husbandry. *Messrs. Margolf and Mueller*  
505. RESEARCH IN POULTRY HUSBANDRY (1-15 per semester) Prerequisite: 9 credits in poultry husbandry.  
506. SEMINAR IN POULTRY HUSBANDRY (1-6)

## PSYCHOLOGY

CLARENCE R. CARPENTER, *Head of the Department*  
112 Burrowes Building

The department offers graduate work leading to the M.S. and Ph.D. degrees. In special cases the M.Ed. and the D.Ed. may be obtained.

Areas in which a student may specialize are: (1) clinical psychology, which includes professional training for mental hygiene clinics, colleges, and institutions; (2) educational and developmental psychology, which prepares for college teaching, teacher education, and educational clinics; (3) experimental and general psychology, which prepares for college teaching and for academic and professional specialties; (4) school psychology, which prepares for work in the public schools and for the Pennsylvania State Certificate as a Public School Psychologist; (5) industrial and business psychology, which prepares for positions in the application of psychology to business, industry, institutions, and state and federal agencies; (6) social psychology, which prepares for college teaching, work in applied social psychology—group dynamics, delinquency, attitude studies, and communications; and (7) psychological measurements and statistics, which provide basic skills for college teaching, work in admission and evaluation programs, test publishing organizations, state and federal agencies, and for most of the areas listed above.

The Penn State Anechoic Chamber provides an exceptional facility for research in hearing for students in experimental and industrial psychology. The Psychology Clinic offers unique training in the clinical and counseling areas. Closed-circuit television facilities also enable interested students to gain experience with research in teaching and the use of this medium.

Requirements for admission include a broad undergraduate preparation, a junior-senior scholastic average of approximately B, a minimum of 12 credits in psychology, and a satisfactory graduate student rating on a scholastic aptitude examination. Applicants with a master's degree will have their admission evaluated with emphasis on the quality of their graduate program.

## PSYCHOLOGY (PSY)

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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|
| 400. HONORS COURSE IN PSYCHOLOGY (2-6)                                                                                                                                                        |                                      |
| 401. (P.H. 401, Zool. 401). ANIMAL BEHAVIOR (3)                                                                                                                                               | <i>Mr. Hale</i>                      |
| 403. INTRODUCTORY PHYSIOLOGICAL PSYCHOLOGY (3)                                                                                                                                                | <i>Mr. Slivinske</i>                 |
| 407. INTERMEDIATE EXPERIMENTAL PSYCHOLOGY (3)                                                                                                                                                 | <i>Mr. Lepley</i>                    |
| 411, 411X. PSYCHOLOGY OF THE PRESCHOOL CHILD (3)                                                                                                                                              | <i>Mr. Whaley</i>                    |
| 412, 412X. ABNORMAL PSYCHOLOGY (3)                                                                                                                                                            | <i>Mr. Guthrie</i>                   |
| 414, 414X. INTERMEDIATE EDUCATIONAL PSYCHOLOGY (2-3)                                                                                                                                          | <i>Mr. Thevaos</i>                   |
| 415, 415X. INTERMEDIATE STATISTICS IN PSYCHOLOGY AND EDUCATION (3)                                                                                                                            | <i>Mr. Ray</i>                       |
| 417. SOCIAL PSYCHOLOGY (2-3)                                                                                                                                                                  | <i>Mr. Carpenter</i>                 |
| 418. MEASUREMENT OF PERSONALITY (3)                                                                                                                                                           |                                      |
| 419. GUIDANCE AND EDUCATION IN SEXUAL AND MARITAL ADJUSTMENT (3)                                                                                                                              | <i>Mr. Adams</i>                     |
| 420. APPLIED SOCIAL PSYCHOLOGY (3)                                                                                                                                                            | <i>Mr. Carpenter</i>                 |
| 422. PSYCHOLOGICAL METHODS OF MEASURING THE REACTIONS OF THE PUBLIC (3)                                                                                                                       |                                      |
|                                                                                                                                                                                               | <i>Mr. Guest</i>                     |
| 423. TEST CONSTRUCTION AND STANDARDIZATION (2-3)                                                                                                                                              | <i>Mr. Ray</i>                       |
| 425, 425X. PSYCHOLOGY OF THE ELEMENTARY SCHOOL CHILD (2-3)                                                                                                                                    | <i>Mr. van Ormer</i>                 |
| 426, 426X. ADOLESCENCE (2-3)                                                                                                                                                                  | <i>Mr. Thevaos</i>                   |
| 427. PSYCHOLOGICAL PRINCIPLES IN ADVERTISING (3)                                                                                                                                              | <i>Mr. Guest</i>                     |
| 428. OPINION RESEARCH LABORATORY (3)                                                                                                                                                          | <i>Mr. Guest</i>                     |
| 429. PSYCHOLOGY OF COMMUNICATION (3)                                                                                                                                                          | <i>Mr. Slivinske</i>                 |
| 431, 431X. INDUSTRIAL PSYCHOLOGY (3)                                                                                                                                                          | <i>Mr. Smith</i>                     |
| 432, 432X. INTRODUCTORY ENGINEERING PSYCHOLOGY (3)                                                                                                                                            | <i>Mr. Corso</i>                     |
| 436, 436X. MENTAL HYGIENE IN SCHOOLS (3)                                                                                                                                                      | <i>Mr. Gorlow</i>                    |
| 437, 437X. PSYCHOLOGY OF ADJUSTMENT (3)                                                                                                                                                       | <i>Messrs. Gorlow and Grosslight</i> |
| 438. THEORY OF PERSONALITY (3)                                                                                                                                                                | <i>Mr. Siegel</i>                    |
| 440. PSYCHOLOGY PROJECTS (1-6)                                                                                                                                                                |                                      |
| 441. INDUSTRIAL MOTIVATION AND MORALE (3)                                                                                                                                                     |                                      |
| 445. (C.D.F.R. 445). DEVELOPMENT THROUGHOUT ADULTHOOD (3)                                                                                                                                     |                                      |
| 450, 450X. MEASUREMENT OF ABILITIES (3)                                                                                                                                                       | <i>Mr. Ray</i>                       |
| 482. INTRODUCTION TO CLINICAL PSYCHOLOGY (3)                                                                                                                                                  | <i>Mr. Snyder</i>                    |
| 500. SEMINAR: INTRODUCTION TO GRADUATE STUDY (0) For all new graduate students in psychology.                                                                                                 | <i>Mr. Carpenter</i>                 |
| 501. ADVANCED PSYCHOLOGY (3) Comprehensive study of general psychology. Prerequisite: 9 credits in psychology.                                                                                | <i>Mr. Lepley</i>                    |
| 502. ADVANCED EDUCATIONAL PSYCHOLOGY (2-4) Psychological theories and principles underlying educational theories and practices. Prerequisites: Psy. 14 or 414; Ed. 31 or teaching experience. | <i>Messrs. Thevaos and Whaley</i>    |



## PSYCHOLOGY

503. **PHYSIOLOGICAL PSYCHOLOGY (2-6)** Correlations between structure and function of nervous system and human consciousness; laws and theories in fields of sensation, attention, association, affection, and thought. Prerequisite: 9 credits in psychology. *Mr. Slivinske*
504. **COMPARATIVE PSYCHOLOGY (2-4)** Behavior from standpoint of phylogenetic growth and development; biological implications; comparison of different types of animals, including man. Prerequisite: 9 credits in psychology. *Mr. Hale*
505. **RESEARCH PROBLEMS IN PSYCHOLOGY (1-15)** Prerequisite: 12 credits in psychology.
509. **ADVANCED THEORY OF LEARNING AND HABIT FORMATION (2-3)** Critical evaluation of major theories of learning: Hull, Guthrie, Tolman, Lewin. Application of learning theory to major problems in psychology. Prerequisite: Psy. 4 or 407 or 414. *Mr. Grosslight*
510. **HISTORY OF PSYCHOLOGY (3)** Theoretical systems, experiments, and personalities in development of modern psychology until about 1920. Prerequisite: 9 credits in psychology. *Mr. Carpenter*
511. **CONTEMPORARY AMERICAN PSYCHOLOGY (2-3)** Current systems or schools of psychology with comparative study and critical analysis; points of view as presented by recognized leaders. Prerequisite: 9 credits in psychology. *Mr. Hall*
513. **EDUCATIONAL PSYCHOLOGY: DIFFERENTIAL (3)** Causes of differences in achievement and personality; psychological implications of methods used by schools in adjusting to individual differences. Prerequisites: Psy. 14 or 414; 6 credits at 400 level in psychology. *Mr. van Ormer*
514. **EDUCATIONAL PSYCHOLOGY: LEARNING (2)** Experimentally determined facts about the learning process; synthesis of main theories of learning; application of principles related to: motivation, practice, retention, transfer, meaning, and problem solving. Prerequisites: Psy. 14 or 414; 6 credits at 400 level in psychology. *Messrs. van Ormer and Thevaos*
515. **ADVANCED STATISTICS IN PSYCHOLOGY AND EDUCATION (3)** Correlation theory and methods, discriminant function, and factor analysis; applications to mental test theory. Prerequisite: Psy. 415 or Ed. 574. *Mr. Siegel*
517. **PSYCHOLOGY OF ATTITUDES AND OPINIONS (3)** Acquisition and control of attitudes and opinions, including beliefs, convictions, biases, prejudices, and ideologies as determinants of action. Prerequisite: 18 credits in psychology, including Psy. 417, 422, 437.
518. **PROJECTS IN EXPERIMENTAL PSYCHOLOGY (2-4)** Individual experimental projects; seminars on experimental design and instrumentation. Prerequisite: Psy. 407.
522. **ADVANCED PSYCHOLOGICAL MARKETING RESEARCH TECHNIQUES (3)** Questionnaire designs to test consumer reaction to products, advertising, and company policies from psychological standpoint. Prerequisite: 3 credits in statistics. *Mr. Guest*
525. **SAMPLING DESIGNS IN MARKET AND OPINION RESEARCH (3)** Techniques in selection of samples for accurate representation of human populations; special emphasis on probability sampling. Prerequisite: 3 credits in statistics. *Mr. Guest*

527. STATISTICAL INFERENCE AND EXPERIMENTAL DESIGN (3) Probability theory, sampling distributions, analysis of variance and covariance, analysis of trend, non-parametric statistics, experimental design. Prerequisite: Psy. 415 or Ed. 574.  
*Mr. Ray*
528. OPINION RESEARCH ADMINISTRATION (3-6) Practicum in planning, development of techniques, and administration of the sample survey. Prerequisites: Psy. 15, 21, 422.  
*Mr. Guest*
529. (C.D.F.R. 529). SEMINAR IN CHILD DEVELOPMENT (1-6) Readings and reports on recent findings in child development. Prerequisite: 6 credits in child development or 6 in educational or child psychology, plus 3 in statistics.
534. ADVANCED ENGINEERING PSYCHOLOGY (3) Experimental studies of psychological factors affecting design and operation of machines. Prerequisites: Psy. 3 and 4, or Psy. 432 or 501.  
*Mr. Corso*
- 535, 535X. HUMAN DEVELOPMENT (2-3) Psychological phases of human development throughout the life span; implications for school, community, and home. Prerequisite: 9 credits in psychology.  
*Messrs. van Ormer and Whaley*
536. RESEARCH METHODS AND PROBLEMS IN EDUCATIONAL AND DEVELOPMENTAL PSYCHOLOGY (1-6) Prerequisites: Psy. 414 or 514; Ed. 470 or Psy. 415.
537. SEMINAR IN INDUSTRIAL PSYCHOLOGY (3) Prerequisite: Psy. 431.  
*Mr. Smith*
538. PSYCHOLOGY OF PERSONNEL DEVELOPMENT (3) Industrial training in relation to psychological learning theory and experimental findings. Prerequisite: Psy. 431 or 414.  
*Mr. Smith*
539. MOTIVATION AND EMOTION (3) Systematic status of instinct, drive, motive, will, purpose; methodology and results of physiological, experimental, and clinical investigation of basic drives. Prerequisite: Psy. 503.  
*Mr. Hall*
540. CLINICAL PSYCHOLOGY SEMINAR (1-6) Seminar on current problems in clinical psychology. Prerequisite: Psy. 482.
541. DYNAMICS OF HUMAN ADJUSTMENT (3) Seminar on motivation of human behavior, frustration, and mechanisms of adjustment; normal behavior is stressed. Prerequisite: Psy. 437.  
*Mr. Gorlow*
542. PSYCHOPATHOLOGY (3) Covers basic, developmental, human, experimental reactions, showing how normal and pathological character trends and deviations evolve; basic reasons for and applications of psychotherapeutic methods. Prerequisite: Psy. 412 or 437.  
*Dr. Lott*
543. COUNSELING TECHNIQUES (2) Survey of psychotherapeutic methods; history, theory, and methods employed; case illustrations. Prerequisite: Psy. 482.  
*Mr. Snyder*
550. PSYCHOMETRICS: BINET (2) Measurement of intelligence by Stanford revision of the Binet-Simon technique; demonstrations, lectures; practice administering tests; observations of student by instructor. Prerequisite: Psy. 450.
551. PSYCHOMETRICS: POINT SCALES (2) Measurement of intelligence by individual nonverbal techniques: Arthur, Wechsler-Bellevue, and others; demonstrations, lectures, and practice administering tests under observation. Prerequisite: Psy. 450.

## PSYCHOLOGY

552. **PSYCHOMETRICS: PRESCHOOL (2)** Measurement by individual preschool scales: Merrill-Palmer, Minnesota, California First Year; demonstration, lectures, and practice in administering tests under observation. Prerequisite: Psy. 551.
553. **PSYCHOMETRICS: ADVANCED (2)** Measurement of intelligence, social maturity, and other characteristics; demonstration, lectures, and practice in administering tests; observations by instructor. Prerequisite: Psy. 550.
555. **PSYCHOMETRICS: RORSCHACH ADMINISTRATION (3)** Introduction to theory of projective tests; supervised practice in administering and scoring of the Rorschach test. Prerequisite: Psy. 550 or 551. *Messrs. Guthrie and Gorlow*
556. **PSYCHOMETRICS: RORSCHACH INTERPRETATION (3)** Study of current literature and supervised practice. Prerequisite: Psy. 555. *Messrs. Guthrie and Gorlow*
557. **PSYCHOMETRICS: ADVANCED PROJECTIVE TECHNIQUES (2-3)** Survey of common projective techniques other than the Rorschach, with supervised practice. Prerequisite: Psy. 556. *Messrs. Guthrie and Gorlow*
- \*560. **CLINICAL PRACTICUM (1-8)** Applied experience in techniques of clinical psychology; case work in the Psychology Clinic. Prerequisites: Psy. 482, 550, 551.
561. **CLINICAL PRACTICUM: ELEMENTARY SCHOOL (1-3)** Experience in the Psychology Clinic and public schools in learning and adjustment problems; diagnosis and remedial work; pertinent school laws and practices. Prerequisites: Psy. 560 and Ed. 70, or Ed. 432g or 470.
562. **CLINICAL PRACTICUM: VOCATIONAL GUIDANCE (1-3)** Practical experience in the Psychology Clinic on high school, college, and adult vocational guidance cases; staff meetings; seminar on techniques and materials. Prerequisite: Psy. 560 or Ed. 502.
563. **CLINICAL PRACTICUM: MARITAL COUNSELING (1-3)** Experience in the Psychology Clinic on premarital and marital adjustment; seminar on techniques of adjustment and development of sexual and emotional maturity in marriage. Prerequisite: Psy. 560. *Mr. Adams*
- 564, 564X. **CLINICAL PRACTICUM: PERSONAL ADJUSTMENT COUNSELING (2-3)** Advanced practicum with experience in counseling of personal adjustment problems referred to the Psychology Clinic. Prerequisite: Psy. 565. *Mr. Snyder*
565. **CLINICAL PRACTICUM: NONDIRECTIVE COUNSELING (3)** Practical experience in application of the nondirective method, along with systematic theoretical study of the method. Prerequisites: Psy. 543, 560. *Mr. Snyder*
566. **CLINICAL PRACTICUM: HYPNOTHERAPY (1-3)** Practical experience in the Psychology Clinic in use of hypnotherapy; staff meetings; seminar on principles and techniques. Prerequisites: Psy. 543, 560.
567. **CLINICAL PRACTICUM: PLAY THERAPY (1-3)** Practical experience in the Psychology Clinic in use of play therapy with young children; staff meetings; seminar on principles and techniques. Prerequisites: Psy. 543, 560.

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\* Not more than 4 credits per semester.



568. CLINICAL PRACTICUM: GROUP THERAPY (2) Practical experience in the Psychology Clinic in use of group methods for treatment of personal maladjustment; staff meetings; seminar on principles and techniques. Prerequisite: Psy. 565.

Mr. Gorlow

569. CLINICAL PRACTICUM: ADVANCED NONDIRECTIVE (2) Practical experience in the Psychology Clinic in advanced nondirective therapy techniques; staff meetings; case conferences. Prerequisite: Psy. 565.

Mr. Snyder

570. INTERNSHIP IN PROFESSIONAL PSYCHOLOGY (1-9) Internship, under supervision of graduate faculty, in institution with practicing psychologists, where student is not regularly employed. Prerequisite: 3 semesters of graduate work in psychology.

Unit A. *Comparative Psychology*

Unit B. *Educational and Developmental Psychology*

Unit C. *General Experimental Psychology*

Unit D. *Industrial and Business Psychology*

Unit E. *Social Psychology*

Unit F. *State Institutional Psychology*

574. MENTAL DEFICIENCY (3) Causes of mental deficiency; diagnosis, training, and care of mental defectives. Prerequisite: Psy. 414 or 482.

580. THEORY AND CONSTRUCTION OF ATTITUDE SCALES (3) Measurement of social, political, commercial, and industrial attitudes; questionnaire designs. Prerequisite: 3 credits in statistics.

Mr. Guest

590. SEMINAR: ADVANCED (1-2) Prerequisite: Psy. 500.

591. SEMINAR ON TEACHING PSYCHOLOGY (1-3) Objectives and content of psychology; organization and presentation of material; teaching aids and techniques.

Mr. Whaley

## RECREATION EDUCATION

FRED M. COOMBS, *in Charge of Recreation Education*  
244 Recreation Building

Graduate work leading to the M.Ed., M.S., D.Ed., and Ph.D. degrees is offered. Students may prepare for recreation administrative positions in public recreation systems, industries, hospitals, camps, or private agencies; or for leadership of special groups in a particular activity. The areas for specialization include: (1) history, philosophy, and principles; (2) administration and supervision; (3) planning areas and facilities; (4) program content and application; (5) surveys and appraisals; (6) principles of the group process; and (7) research.

For admission an undergraduate major in recreation education is desirable; but a major in sociology, music, physical education, fine or industrial arts, theatre arts, or other related fields may be accepted.

Students who lack some of the prerequisite courses may be admitted but are required to make up the deficiency without degree credit.

## RECREATION EDUCATION

### RECREATION EDUCATION (RC ED)

430. CAMPING AND OUTDOOR EDUCATION (3)  
434. (L.Arch. 434). RECREATION AREAS AND FACILITIES (3)  
456, 456X. SOCIAL RECREATION (3)  
461, 461X. COMMUNITY RECREATION (3)  
462. RECREATION FOR THE HANDICAPPED (3)  
465, 465X. ADMINISTRATION OF RECREATION (3)
530. CAMP ADMINISTRATION (3) Camp site development; staff selection, training, and supervision; development of objectives and program planning; values inherent in outdoor and camping education. Prerequisite: Rc.Ed. 430.
533. RECREATION STUDIES, SURVEYS, AND APPRAISALS (3) Types, purposes, and methods of conducting recreation studies and surveys; procedures in appraisal of community recreation. Prerequisite: Ph.Ed. 530.
560. ADMINISTRATIVE PROBLEMS OF RECREATION (3) Administrative problems in park and recreation departments; departmental organization, finance, personnel, facilities, program, and public relations. Prerequisite: Rc.Ed. 465.

## ROMANCE LANGUAGES AND LITERATURES

FRANKLIN B. KRAUSS

*Head of the Department of Romance Languages*  
301 Sparks Building

The M.A. and Ph.D. are offered with a major in Romance languages and literatures. The minimum requirement for admission to an advanced degree program will normally be the basic 24 credits of the undergraduate major program at this University or the equivalent thereof. A student electing to concentrate in either French or Spanish may, if he wishes, choose the second area as a minor.

### FRENCH (FR)

400. FRENCH LITERATURE OF THE RENAISSANCE (3)  
405. FRENCH LITERATURE IN THE ROMANTIC PERIOD (3)  
406. FRENCH LITERATURE IN THE REALISTIC PERIOD (3)  
411. FRENCH PROSE OF THE 20TH CENTURY (3)  
413, 413X. CONTEMPORARY FRENCH DRAMA (3)  
416. FRENCH POETRY AND DRAMA OF THE 20TH CENTURY (3)  
421. THE TEACHING OF ROMANCE LANGUAGES (3)  
431. FRENCH LITERATURE OF THE CLASSICAL PERIOD (3)  
433. THE AGE OF ENLIGHTENMENT (3)  
437. THE FRENCH ANALYTICAL NOVEL (3)  
471. PROBLEMS IN FRENCH LITERATURE (3-6)  
490. ADVANCED COMPOSITION AND CONVERSATION (3)  
496. LITERARY CRITICISM IN FRANCE, ITALY, AND SPAIN (3)
- \*1G. ELEMENTARY FRENCH FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.

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\* No graduate credit is given for this course.

## ROMANCE LANGUAGES AND LITERATURES

501. **FRENCH DRAMA OF THE CLASSICAL PERIOD (3)** Origins and development of French classical comedy and tragedy, emphasizing the works of Corneille, Racine, and Molière.
549. **SYMBOLISM (3)** The anti-positivistic tradition in 19th century French literature dealing with the Symbolist School, its antecedents and its subsequent ramifications.
552. **MEDIEVAL FRENCH LITERATURE (3)** Familiarizes the student with Old and Middle French texts from the earliest monuments to Villon. Prerequisite: R.Ph. 551.
553. **FRENCH LITERATURE OF THE RENAISSANCE (3)** The French Renaissance from 1498 to 1548.
562. **FRENCH THINKERS OF THE 18TH CENTURY (3)**
564. **FRENCH ROMANTICISM (3)** The French Romantic movement after 1830.
570. **VOLTAIRE AND ROUSSEAU (3)**
571. **SEMINAR IN FRENCH LITERATURE (3-12)** Lectures on methods of research. Students will pursue common and individual investigations in fields selected after consultation with the instructor.
572. **SEMINAR IN FRENCH LITERATURE (3)** Continuation of Fr. 571.
580. **PROUST AND GIDE (3)**

### ITALIAN (IT)

571. **SEMINAR IN ITALIAN LITERATURE (3)** Lectures on methods of research. Students will pursue common and individual investigations in fields selected after consultation with the instructor.

### PORTUGUESE (PORT)

571. **SEMINAR IN PORTUGUESE LITERATURE (3-6)** Prerequisite: Port. 4.

### SPANISH (SPAN)

401. **THE GOLDEN AGE (3)**
402. **DRAMA OF THE GOLDEN AGE (3)**
403. **DON QUIXOTE (3)**
404. **OLD SPANISH LANGUAGE AND LITERATURE (3)**
405. **SPANISH DRAMA OF THE 19TH CENTURY (3)**
406. **CONTEMPORARY SPANISH DRAMA (3)**
407. **THE SPANISH NOVEL OF THE 19TH CENTURY (3)**
408. **THE CONTEMPORARY SPANISH NOVEL (3)**
- 409, 409X. **INTRODUCTION TO LATIN-AMERICAN LITERATURE (3)**
410. **INTRODUCTION TO LATIN-AMERICAN LITERATURE (3)**
411. **MEXICO: ITS LANGUAGE AND LITERATURE (3)**
412. **ARGENTINA: ITS LANGUAGE AND LITERATURE (3)**
415. **MODERN SPANISH LYRIC POETRY (3)**
417. **SPANISH LITERATURE IN THE ROMANTIC PERIOD (3)**
421. **THE TEACHING OF ROMANCE LANGUAGES (3)**
471. **PROBLEMS IN SPANISH LITERATURE (3-6)**
490. **ADVANCED COMPOSITION AND CONVERSATION (3)**
496. **LITERARY CRITICISM IN FRANCE, ITALY, AND SPAIN (3)**



## ROMANCE LANGUAGES AND LITERATURES

- \*1G. ELEMENTARY SPANISH FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.
501. GOLDEN AGE LITERATURE (3) Nature and development of Spanish literature of the 16th and 17th centuries.
538. THE GENERATION OF 1898 (3) Principal works and intellectual trends of the period with special emphasis on Unamuno.
549. MODERNISMO (3) The movement, its antecedents, and its followers, with special emphasis on Rubén Darío.
552. MEDIEVAL SPANISH LITERATURE (3) Familiarizes the student with Old Spanish texts.
- 561-562. SPANISH DRAMA PREVIOUS TO LOPE DE VEGA (3 each) Origin and early development of the Spanish national drama. Representative plays of different types will be read and discussed.
565. LOPE DE VEGA (3)
566. LOPE DE VEGA'S FOLLOWERS (3)
- 567-568. CERVANTES AND HIS WORKS (3 each)
571. SEMINAR IN SPANISH LITERATURE (3-12) Lectures on methods of research. Students will pursue common and individual investigations in fields selected after consultation with the instructor.
572. SEMINAR IN SPANISH LITERATURE (3) Continuation of Span. 571.

### ROMANCE LITERATURE (R LIT)

544. NEOCLASSICISM IN THE ROMANCE LITERATURES (3) The neoclassical movement in the Romance literatures, with emphasis on French and Spanish.
545. ROMANTICISM IN THE ROMANCE LITERATURES (3) The Romantic movement in the Romance literatures, with emphasis on French and Spanish.
546. MEDIEVAL ROMANCE LITERATURES (3) Medieval writings in the Romance literatures, with emphasis on French and Spanish.
547. REALISM IN THE ROMANCE LITERATURES (3) The Realistic movement in the Romance literatures, with emphasis on French and Spanish.
554. THE RENAISSANCE IN THE ROMANCE LITERATURES (3) The effect of the Renaissance on the Romance literatures, with emphasis on French and Spanish.

### ROMANCE PHILOLOGY (R PH)

551. ROMANCE PHILOLOGY (3)
558. ADVANCED LINGUISTICS AND PHONETICS OF THE ROMANCE LANGUAGES (3)
573. THEORY AND TECHNIQUES OF TEACHING THE ROMANCE LANGUAGES (1-2)
574. METHODS AND BIBLIOGRAPHY IN ROMANCE LANGUAGES AND LITERATURES (1-2)

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\* No graduate credit is given for this course.

## RURAL SOCIOLOGY

MACKLIN E. JOHN

*Head of the Department of Agricultural Economics and Rural Sociology*  
1 Weaver Building

A graduate program leading to the M.S. or the Ph.D. degree is offered. The entering student in the master's program should have as prerequisites 3 credits in rural sociology, 3 credits in sociology, and 3 additional credits in either field. If he does not have these prerequisites, he may take them at this University during the early part of his master's program.

### RURAL SOCIOLOGY (R SOC)

- 452. RURAL ORGANIZATION (3)
- 454. RURAL SOCIAL WELFARE (3)
- 456. RURAL STANDARDS OF LIVING (3)
- 459. RURAL SOCIAL PSYCHOLOGY (3)
  
- 551. RURAL SOCIOLOGY SEMINAR (1-6) Prerequisite: 6 credits in rural sociology, sociology, or psychology.
- 552. ADVANCED RURAL SOCIOLOGY (3) Structure and functioning of rural society.
- 553. SEMINAR IN RURAL SOCIOLOGICAL RESEARCH (1-6) Continuation of R.Soc. 552. Functioning of rural society; research dealing with the subject reviewed and evaluated.
- 554. ADVANCED RURAL SOCIAL WELFARE (3) Analysis of welfare techniques and their application to rural situations. Prerequisites: R.Soc. 11; Psy. 2 or R.Soc. 459.
- 555. THE RURAL CHURCH (3) The rural church as a social institution; its relation to the community; the church in "problem" areas; effects of population trends on the program of the rural church; use of case studies and surveys. Prerequisite: 6 credits in rural sociology, sociology, or psychology.
- 557. THE DEVELOPMENT OF THE RURAL COMMUNITY (3) Origin and evolution of the rural community under different geographic and cultural conditions. Prerequisites: R.Soc. 11 or Soc. 1; R.Soc. 452.
- 559. ADVANCED RURAL SOCIAL PSYCHOLOGY (3) Application of social psychological principles to treatment of rural problems. Prerequisites: R.Soc. 11, Psy. 2.

## SOCIAL STUDIES

NEIL A. McNALL

*Chairman of the Committee on Social Studies*  
115 Sparks Building

The M.Ed. degree is offered with a major in social studies. The program, which is designed to meet the needs of secondary school teachers, consists of at least 24 credits chosen from economics, history, human geography, political science, and

sociology, and a minor of at least 6 credits in basic education. A candidate is expected to complete at least 3 credits in each of four fields and not more than 12 credits in one of them.

To undertake graduate work in this field, the student must have had solid preparation in the basic courses in history, political science, economics, and sociology; and he should have had some advanced undergraduate work in at least one of the fields named. He should be certified for teaching social studies, and ideally he should have had teaching experience in this field as well.

## SOCIOLOGY

WILLIAM G. MATHER, *Head of the Department*  
123 Sparks Building

Graduate work leading to the M.A. and Ph.D. degrees is offered in sociology. A minor may be taken in anthropology. Undergraduate preparation must include 12 credits in sociology and at least 7 in other social sciences, with a broad background in the arts and sciences preferred. Students of exceptional ability who are slightly deficient in undergraduate preparation may be accepted, on condition that they make up their deficiency in courses without degree credit.

### SOCIOLOGY (SOC)

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|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| 401. SOCIAL INSTITUTIONS (3)                                                                                                                                                                                                                                                                                 | Mr. Green              |
| 403. ADVANCED SOCIAL PSYCHOLOGY (3)                                                                                                                                                                                                                                                                          | Mr. Coutu              |
| 408. SOCIAL ECOLOGY (3)                                                                                                                                                                                                                                                                                      |                        |
| 413. METHODS AND TECHNIQUES OF SOCIAL RESEARCH (1-6)                                                                                                                                                                                                                                                         | Mrs. Bernard           |
| 418. THE DEVELOPMENT OF SOCIAL THOUGHT (3)                                                                                                                                                                                                                                                                   |                        |
| 423. POPULATION RESEARCH (3)                                                                                                                                                                                                                                                                                 | Mr. Clark              |
| 424. SOCIAL CHANGE (3)                                                                                                                                                                                                                                                                                       | Mr. Abramson           |
| 425. CONTEMPORARY SOCIOLOGICAL THEORY (3)                                                                                                                                                                                                                                                                    | Mr. Green              |
| 426. INTRODUCTION TO PUBLIC WELFARE (3)                                                                                                                                                                                                                                                                      | Mr. Mather             |
| 427. SOCIAL CASE WORK (3)                                                                                                                                                                                                                                                                                    |                        |
| 429. SOCIAL STRATIFICATION (3)                                                                                                                                                                                                                                                                               | Mr. Abramson           |
| 431. COMMUNICATION AND MASS SOCIETY (3)                                                                                                                                                                                                                                                                      | Mr. Abramson           |
| 450. COMMUNITY ORGANIZATION (3)                                                                                                                                                                                                                                                                              |                        |
| 470. USE OF STATISTICS IN SOCIOLOGY (3)                                                                                                                                                                                                                                                                      | Mr. Clark              |
| 499X. FOREIGN STUDY IN SOCIOLOGY (2-6)                                                                                                                                                                                                                                                                       |                        |
| 500. SEMINAR IN GROUP THEORY (1-3) The group as a unit of social structure and action.                                                                                                                                                                                                                       |                        |
| 503. SEMINAR IN SOCIAL PSYCHOLOGY (3-9) Investigation of theories, methods, and empirical data of social psychology, with particular reference to such problems as relations between personality and culture, social and personal disorganization, development of role behavior, and conception of the self. |                        |
|                                                                                                                                                                                                                                                                                                              | Mr. Coutu              |
| 510. FIELD WORK IN SOCIOLOGY (1-6)                                                                                                                                                                                                                                                                           |                        |
| 513. SEMINAR IN SOCIOLOGICAL RESEARCH PROBLEMS: A. RESEARCH TECHNIQUES; B. CURRENT RESEARCH (3-6) Prerequisites: Soc. 413; 3 credits in statistics.                                                                                                                                                          |                        |
|                                                                                                                                                                                                                                                                                                              | Mr. John, Mrs. Bernard |



515. SEMINAR IN COMMUNITY STUDIES (3) *Mrs. Bernard*
516. SEMINAR IN SOCIOLOGICAL THEORY (3-9) *Mr. Green*
523. POPULATION PROBLEMS (1-9) *Mr. Clark*
525. SEMINAR IN SOCIOLOGY (1-9) Research problems in theoretical and applied sociology. *Mr. Clark*
530. RESEARCH ON MARRIAGE AND THE FAMILY (3) Training in methods and techniques of research in family relations. Experimental, statistical, and comparative studies are carried out, individually or co-operatively. Prerequisite: 3 credits of previous work in this field. *Mrs. Bernard*
572. METHODS OF SAMPLING (3) Application of sampling techniques to sociological research. *Mr. Clark*

## SPEECH

ROBERT T. OLIVER, *Head of the Department*  
300 Sparks Building

Graduate programs are offered which lead to the M.A., M.Ed., D.Ed., and Ph.D. degrees. The student may specialize in speech arts (interpretation, drama, theatre); radio and television; rhetoric and public address (including discussion, communication, teaching of speech); speech science (voice, diction, phonetics, general semantics); or speech pathology and audiology.

The minimum undergraduate preparation required is 12 credits in speech including Spch. 200, Effective Speech, and Spch. 320, Speech Science, or their equivalents. Students who cannot meet this requirement in full may be admitted but must make up their deficiencies without credit toward the graduate degree. If Spch. 401 or an equivalent course at the graduate-undergraduate level is not offered for admission, it will be required as a part of the graduate program.

### SPEECH (SPCH)

- 400, 400X. TEACHING OF SPEECH (3) *Mr. Schug*
401. PROBLEMS, METHODS, AND AREAS IN SPEECH (3) *Mr. Carter*
402. INTRODUCTION TO GENERAL SEMANTICS (3) *Mr. Carter*
410. ENGLISH PHONETICS AND PRONUNCIATION (3) *Mr. Brubaker*
412. SPEECH COMPOSITION (3) *Mr. DeBoer*
415. EXPERIMENTAL AND APPLIED PHONETICS (3) *Mr. Brubaker*
425. ADVANCED PRINCIPLES OF RADIO SPEECH (3) *Mr. Nelson*
431. ANATOMY AND PHYSIOLOGY OF THE EAR AND VOCAL MECHANISMS (3) *Mr. Brubaker*
435. TELEVISION AND RADIO ORGANIZATION (3) *Mr. Nelson*
437. ADVANCED PRINCIPLES OF TELEVISION SPEECH (3) *Mr. Nelson*
445. SPEECH AS A MEDIUM OF INTERNATIONAL RELATIONS (3) *Mr. Oliver*
450. DISCUSSION TECHNIQUES (3) *Mr. Joseph O'Brien*
500. SEMINAR IN AMERICAN ORATORY (2-4) History of American oratory, with application of critical standards to the work of specific orators. Prerequisite: 6 credits in speech, including Spch. 200. *Mr. Joseph O'Brien*

## SPEECH

505. HISTORICAL DEVELOPMENT OF SPEECH THEORY (2-4) Survey of ancient, medieval, and modern theories of public address in relation to currently accepted speech theories. *Mr. DeBoer*
508. SEMINAR IN BRITISH ORATORY (2-4) History of British oratory; application of critical standards to the work of selected orators. *Miss Fife*
510. SEMINAR IN SPEECH PEDAGOGY (2-4) *Mr. Carter*
520. SEMINAR IN SPEECH SCIENCE (2-4) Seminar in physical and physiological bases of speech and voice; introduction to laboratory techniques used in speech research. Prerequisite: 9 credits in speech, speech education, or psychology. *Mr. Brubaker*
540. SEMINAR IN PROBLEMS OF TELEVISION AND RADIO (2-4) Study and research in television and radio as they pertain to programming, production, relation to society, and speech. *Mr. Nelson*
550. SEMINAR IN ORAL PERSUASION (2-4) Theory and devices of persuasion; analysis of persuasive discourse. Prerequisite: 6 credits in speech including Spch. 200. *Mr. Oliver*
552. ORAL COMMUNICATION IN INDUSTRY, BUSINESS, AND GOVERNMENT (2-4) Needs, practices, and methods in American industry, business, and government; methods of training adults in oral communication skills. *Mr. Zelko*
555. SPEECH COMMUNICATION: PROBLEMS AND PRINCIPLES (2-4) Prevalent theories of speech influence. *Mr. Oliver*
560. PUBLIC ADDRESS (2-4) Discussion and criticism of speech outline, manuscript, content, composition, and delivery. Prerequisite: 6 credits in speech including Spch. 200. *Mr. Schug*
575. RESEARCH PROBLEMS IN SPEECH (1-12) Advanced research on an individual basis in oratorical criticism, discussion techniques, persuasion, pedagogy, phonetics, speech science, and speech pathology. Prerequisite: 12 credits in speech or in speech education.

## STATISTICS

JAMES B. BARTOO, *Chairman of the Committee on Statistics*  
212 Sparks Building

Statistics may be used as a field of study for a minor in an advanced degree program. This minor is intended to facilitate development of a coherent program of study in this vital branch of the scientific method.

An acceptable program should permit the candidate to become conversant with the broad field of statistics and to become reasonably proficient in the statistical methods particularly useful in the subject-matter areas of his major field. The member of the candidate's committee representing the minor in statistics will have responsibility and jurisdiction for determining course work acceptable in satisfying requirements for the minor in statistics.

The minimum requirements for a minor for a master's degree are 3 credits in mathematical statistics and 6 in applied statistics. For a doctor's degree a minimum

of 15 credits in statistics is required for a minor, of which at least 6 must be mathematical statistics and at least 6 must be applied statistics.

Courses in mathematical statistics are: Math. 409, 410, 542, and 543.

Courses in applied statistics are: Ag. 400; A.B.Ch. 515; Ag.Ec. 505; Ag.Ed. 521v, 521vX; Agro. 512, 545; B.S. 500, 501; Econ. 480; Ed. 470, 574; I.E. 423; Meteo. 450; Min. 513, 514, 526; Psy. 415, 515, 527; and Soc. 470, 572.

## THEATRE ARTS

WALTER H. WALTERS, *Head of the Department*  
201 Schwab Auditorium

The M.A. degree is offered with a major in theatre arts. Under certain circumstances the Ph.D. degree is offered by the Department of English Literature with specialization in drama and minor work in theatre arts.

A course in basic acting, one in directing, and one in theatre crafts, or their equivalents, are required for admission. In addition, the student must have had 12 credits divided between speech and the arts (including music, sculpture, painting, architecture, and other courses in which art is practiced); or a minimum of 9 credits in one of these; or a minimum of 9 credits in English and literature, including at least 6 in dramatic literature, or 3 in dramatic literature and 3 in advanced creative writing.

### THEATRE ARTS (THEA)

- 403. ADVANCED MAKE-UP (1)
- 404. STYLES OF ACTING (3)
- 412. ADVANCED SCENE DESIGN (3)
- 413. STAGE LIGHTING (3)
- 421. ADVANCED PLAYWRITING (3)
- 431. HISTORY OF THE THEATRE (3)
- 442. CREATIVE DRAMATICS WITH CHILDREN (3)
- 443. MARIONETTES AND PUPPETRY (3)
- 451. DIRECTING (3)
- 452. CENTRAL STAGING (3)
- 480. RADIO DRAMA (3)
- 481. ADVANCED RADIO DRAMA (3)
  
- 501. PROBLEMS OF DIRECTING (3-6) Seminar in problems of production with particular stress on direction. Students will direct plays under staff supervision.
- 502. SEMINAR IN THE TECHNICAL PROBLEMS OF DRAMATIC PRODUCTION (3-6) Prerequisite: Thea. 11.
- 504. SEMINAR IN STYLES OF ACTING (3-6) Practical work required of each student.
- 506. EVALUATION AND APPRECIATION OF MODERN DRAMATIC ENTERTAINMENT (3) Prerequisites: Thea. 1, 61.
- 507. SEMINAR IN FUNDAMENTAL THEORIES OF THEATRE AND DRAMA (3-6)
- 521. PLAYWRITING (3-6) Prerequisites: Thea. 21, 421.



## WILDLIFE MANAGEMENT

Consult BERTIL G. ANDERSON  
212 Frear Laboratory

The M.S. degree is offered in the field of wildlife management. Candidates select courses for this major from a number of related fields.

## ZOOLOGY

BERTIL G. ANDERSON  
*Head of the Department of Zoology and Entomology*  
212 Frear Laboratory

The Department of Zoology and Entomology offers work leading to the M.S. degree with a major in zoology. Students may specialize in animal behavior, bioacoustics, ecology, endocrinology, fishery biology, genetics, histology, ichthyology, invertebrate zoology, invertebrate physiology, or wildlife management.

In order to undertake graduate work in zoology, students are required to have had 24 credits in zoology and related biological sciences; and they should have had chemistry through organic chemistry. Courses in physics and mathematics are also advantageous. A limited deficiency can be made up without degree credit while pursuing graduate work.

### ZOOLOGY (ZOO)

- |                                                                     |                                    |
|---------------------------------------------------------------------|------------------------------------|
| 401. (P.H. 401, Psy. 401). ANIMAL BEHAVIOR (3)                      | Mr. Hale                           |
| 405. (Bot. 405). GENERAL CYTOLOGY (3)                               | Mr. Grun                           |
| 408. MAMMALOGY (4)                                                  | Mr. English                        |
| 410. GENERAL LIMNOLOGY (3)                                          | Mr. Cooper                         |
| 415. THE LITERATURE OF ZOOLOGY (1)                                  | Mr. B. G. Anderson                 |
| 416. THE METHODS OF RESEARCH IN ZOOLOGY (2)                         | Mr. B. G. Anderson                 |
| 417. INVERTEBRATE ZOOLOGY (3)                                       | Mr. Frings                         |
| 419. GENERAL ANIMAL ECOLOGY (3)                                     | Mr. Blackburn                      |
| 420. GAME BIRDS (3)                                                 | Mr. English                        |
| 421. COMPARATIVE ANATOMY OF VERTEBRATES (4)                         |                                    |
| 422. (Bot. 422). ADVANCED GENETICS (3)                              | Mr. Wright                         |
| 432. HUMAN PARASITOLOGY (3)                                         | Mr. Zelif                          |
| 433. (Bot. 433). GENETICS, EUGENICS, AND EVOLUTION FOR TEACHERS (3) | Messrs. Wright, Grun, and Mitchell |
| 436. PROTOZOOLOGY (3)                                               | Mr. Zelif                          |
| 437. HISTOLOGY (4)                                                  | Mr. Anthony                        |
| 440. EMBRYOLOGY (4)                                                 |                                    |
| 441. ESSENTIALS OF HUMAN PHYSIOLOGY FOR TEACHERS (3)                | Mr. Tietz                          |
| 444. ZOOLOGICAL PROBLEMS (1-6)                                      |                                    |
| 448. ORNITHOLOGY (3)                                                | Mr. Wood                           |
| 450. ICHTHYOLOGY (4)                                                | Mr. Cooper                         |
| 461. ANIMAL PARASITOLOGY (3)                                        | Mr. Zelif                          |

505. (Bot. 505). CYTOLOGY AND CYTOGENETICS (3) Chromosome mechanism of heredity; relationship between plant and animal evolution and breeding and changes in chromosomes; cytological and cytochemical techniques. Prerequisite: Bot. or Zool. 22. *Mr. Grun*
508. ADVANCED PARASITOLOGY (3) Advanced work on the structure, life cycle, and control of parasites. *Mr. Zelif*
509. TECHNIQUES IN WILDLIFE MANAGEMENT (3) Preparing study mounts, census making, management area mapping, methods of collecting data, and determining food habits from stomach contents. Prerequisite: Zool. 546. *Mr. English*
512. SEMINAR (1) Review of current zoological literature. Required of graduate students majoring in zoology and entomology. Prerequisite: 12 credits in zoology or entomology.
514. SPECIAL TOPICS IN ZOOLOGY (3) Individual problems in any field of zoology, with or without experimental work. Prerequisite: Zool. 26.
524. (Bot. 524). SEMINAR IN GENETICS (1 per semester) *Mr. Wright*
528. (Bot. 528.) POPULATION GENETICS (3) Factors affecting gene frequency, genotype frequency, genotype-environmental interaction, and genetic relationship in natural and artificial populations. *Mr. Mitchell*
532. ANIMAL PARASITES (3) Structure, life cycle, and control. *Mr. Zelif*
533. (Bot. 533). PROBLEMS IN GENETICS (2-6) Problems to suit needs of individual students; conferences and laboratory work. Prerequisite: Bot. or Zool. 422. *Messrs. Wright, Grun, and Mitchell*
537. (Bot. 537, Ed. 537). WORKSHOP IN THE BIOLOGICAL SCIENCES (3) Projects designed for teachers of biology in the secondary schools.
541. COMPARATIVE PHYSIOLOGY (3) Dynamics of vital processes as shown in members of the animal kingdom. Prerequisites: Zool. 26, A.B.Ch. 1, A.B.Ch. 425 or Zool. 437. *Mr. Frings*
546. THE THEORY OF GAME MANAGEMENT (4) Fundamental principles underlying management of wild game birds and mammals; co-ordination of such management with various land uses; planning preserves and other land areas. Prerequisites: Zool. 408, 420. *Mr. English*
551. FISHERIES MANAGEMENT (3) Basic principles underlying management of inland waters for fish production. Prerequisite: Zool. 450.
581. ADVANCED INVERTEBRATE ZOOLOGY (3) Morphology, physiology, taxonomy, and life histories of invertebrate animals. *Mr. Frings*
583. GENERAL ENDOCRINOLOGY (2) Anatomy and physiology of the organs of internal secretion; role of hormones in metabolism and development. *Mr. Anthony*
587. BIOLOGY OF SEX (2) Hereditary and embryological aspects, problems in gonadal differentiation, cyclic reproductive phenomena, actions of the hormones. *Mr. Anthony*





## *Part II*

### *Other Elective Graduate Courses*

The following courses involve fields in which neither major nor minor work is offered at this institution. The courses, however, carry graduate credit and, with the approval of the major department, may be applied toward the requirements for a degree either as elective courses or as a part of a general studies program. The usual restrictions upon the use of 400 series courses in degree programs apply to these courses.

#### AGRICULTURE, GENERAL (AG)

400. INTRODUCTORY BIOMETRY (3)

#### ARCHAEOLOGY (ARCHY)

- |                                                |                   |
|------------------------------------------------|-------------------|
| 400-401. ARCHAEOLOGY OF THE NEAR EAST (3 each) | <i>Mr. Matson</i> |
| 402-403. ARCHAEOLOGY OF THE NEW WORLD (3 each) | <i>Mr. Matson</i> |

#### ASTRONOMY (ASTRO)

430. GENERAL ASTRONOMY FOR TEACHERS (3)  
470. SOLAR PHYSICS (3)  
486. ASTRONOMICAL PHOTOGRAPHY (3)  
490-491. INTRODUCTION TO ASTROPHYSICS (3 each)

#### COMMERCIAL CONSUMER SERVICES (C C S)

- |                                            |                     |
|--------------------------------------------|---------------------|
| 403. LECTURE-DEMONSTRATION TECHNIQUES (3)  | <i>Miss Allgood</i> |
| 450. PROBLEMS IN HOUSEHOLD EQUIPMENT (1-6) | <i>Miss Allgood</i> |

#### ENGINEERING (ENGR)

410. NUCLEAR ENGINEERING (3)  
411. NUCLEAR ENGINEERING (3)  
422. ORDNANCE ENGINEERING: TORPEDO ENGINEERING (3)  
430. INTRODUCTION TO DIGITAL COMPUTER PROGRAMMING (1)  
431. DIGITAL COMPUTER PROGRAMMING (3)  
450. PATENT FUNDAMENTALS (3)
500. SPECIAL TOPICS IN ENGINEERING (1-3)
501. REACTOR ENGINEERING (3) Reactor controls, shielding of nuclear reactors, stress analysis of reactor materials, power cycle analysis, breeding, and advanced design considerations. Prerequisite or concurrent: Phys. 566.
502. REACTOR ENGINEERING LABORATORY (1) Reactor experiments devised to acquaint the student with reactor technology. Prerequisite or concurrent: Phys. 566.

## ENGINEERING

531. ADVANCED DIGITAL COMPUTER PROGRAMMING (3) Programming for commercial computers; programming techniques; numerical methods for computers; solution of problems on the Penn State Digital Computer. Prerequisites: Math. 405, Engr. 431.

## GREEK (GREEK)

- |                                      |                 |
|--------------------------------------|-----------------|
| 421. GREEK TRAGEDY (3)               | <i>Mr. Will</i> |
| 422. GREEK COMEDY (3)                | <i>Mr. Will</i> |
| 423. ATTIC ORATORS (3)               | <i>Mr. Will</i> |
| 424. GREEK HISTORY OR PHILOSOPHY (3) | <i>Mr. Will</i> |
| 427. NEW TESTAMENT GREEK (3)         | <i>Mr. Will</i> |

500. GREEK COMPOSITION (2) Translation of extended narrative passages into Attic Greek; thorough review of forms and syntax; attention to rhetorical elements of the language. *Mr. Will*

## HEALTH EDUCATION (HL ED)

403. FIRST AID, ATHLETIC CONDITIONING AND TRAINING (3)
405. RECENT DEVELOPMENTS IN PUBLIC HEALTH EDUCATION (3-6)
406. RECENT DEVELOPMENTS IN SCHOOL HEALTH EDUCATION (3)
- 407, 407X. ADVANCED PERSONAL AND PUBLIC HEALTH (3)
- 411, 411X. PRINCIPLES AND METHODS OF TEACHING SAFETY EDUCATION (3)
427. HEALTH FACTORS IN THE DEVELOPMENT OF THE ADOLESCENT (3)
- 453, 453X. ORGANIZATION AND ADMINISTRATION OF HEALTH EDUCATION (3)
456. ADVANCED TECHNIQUES IN RURAL SCHOOL HEALTH (3)
501. HEALTH IMPLICATIONS IN THE GROWTH AND DEVELOPMENT OF SCHOOL CHILDREN (3) Child growth and development emphasis for teachers; medical inspection and examination; preschool program; early habit formations; behavior problems; co-operation of parents, teachers, and children. Prerequisite: Hl.Ed. 215.
505. ADVANCED TECHNIQUES IN HEALTH EDUCATION (3) Prerequisites: Hl.Ed. 215, 399, Psy. 437.
572. TESTS AND MEASUREMENTS IN HEALTH EDUCATION (3) Critical study, evaluation, and demonstration of tests and measures of health education; statistical computations of data. Prerequisites: Ph.Ed. 490, Hl.Ed. 215, 399.

## HOME-COMMUNITY RELATIONSHIPS (H C R)

- 499X. INTERCULTURAL STUDIES IN HOME ECONOMICS (2-6)
- 502, 502v, 502X, 502vX. HOME ECONOMICS AND AMERICAN SOCIETY (3) Family life education in relation to a democratic culture; emphasis upon the interrelatedness of socioeconomic problems and the American family.
503. GRADUATE SEMINAR IN HOME ECONOMICS (1) *Miss Henderson*

## INTERNATIONAL UNDERSTANDING (INT U)

400. WORLD AFFAIRS AND INTERNATIONAL UNDERSTANDING (3-6)

LATIN (LATIN)

428. LUCRETIVS (3) *Mr. Krauss*  
 429. QVINTILIAN (3) *Mr. Krauss*  
 431. JUVENAL (3) *Mr. Krauss*  
 436. FUNCTIONAL PROBLEMS IN LATIN (3)

500. LATIN LITERATURE (3) Lectures and collateral readings on the major forms of Latin literature; readings in the original Latin to supplement the lectures.  
*Mr. Krauss*

501. ROMAN RELIGION AND PHILOSOPHY (3) Development of religious concepts at Rome from primitive Italic origins to the advanced forms that culminated in Roman Stoicism.  
*Mr. Krauss*

502. LATIN EPIGRAPHY (3) Lectures and readings on Roman inscriptions; illustrative exercises.  
*Mr. Krauss*

503. LATIN PALEOGRAPHY (3) The Latin alphabet, writing materials, Roman book and cursive hands; illustrative exercises.  
*Mr. Krauss*

504. ROMAN TOPOGRAPHY (3) Physical development of the city of Rome, its walls, aqueducts, bridges, streets, forums, public buildings, temples, etc.; building materials and methods of construction.  
*Mr. Krauss*

510. LATIN SEMINAR (3) *Mr. Krauss*

518. LATIN RESEARCH (1-3) Prosecution of an assigned problem under the guidance of a member of the department.

LIBERAL ARTS (L A)

500-501. FUNDAMENTALS OF LINGUISTICS (3 each) Interrelated problems of language discussed from four points of view: modern structural linguistics, historical linguistics, social psychology, and philosophy.

LIBRARY SCIENCE (L SC)

403. INTERMEDIATE DICTIONARY CATALOGING AND SUBJECT HEADINGS (2-3)  
 405. INTERMEDIATE REFERENCE WORK AND BIBLIOGRAPHY (2-3)  
 407. SPECIAL PROBLEMS IN SCHOOL LIBRARY SERVICE (6)

MINERAL INDUSTRIES (MN I)

400. MINERAL INDUSTRIES IN MODERN CIVILIZATION (3)

MINERAL SCIENCES (MN SC)

411. INSTRUMENT TECHNIQUES APPLIED TO MINERAL SCIENCE PROBLEMS (1-3)  
*Unit A. X-Ray Diffraction*  
*Unit B. Electron Microscopy*  
*Unit C. Spectroscopy*

510. X-RAY AND ELECTRON DIFFRACTION ANALYSIS AS APPLIED TO MINERALS AND METALS (2) Prerequisite: Phys. 285.  
*Mr. Brindley*



## MINERAL SCIENCES

520. ELECTRON MICROSCOPY IN MINERAL SCIENCE RESEARCH (1-4) Prerequisite: Mn.Sc. 411, Unit B. *Messrs. Bates and Comer*
530. SPECTROSCOPY IN MINERAL SCIENCE RESEARCH (1-4) Prerequisite: Mn.Sc. 411, Unit C. *Mr. Lovell*
540. SOLID STATE STRUCTURES AND REACTIONS IN MINERAL SYSTEMS (2-4) Crystal chemical approach to solid state reactions, sintering, melting, hardness, thermal expansion, and behavior of matter under high pressure. *Mr. Weyl*

## NATURE EDUCATION (NA ED)

401. TRAINING IN NATURE FOR CAMP COUNSELORS (3)

## PUBLIC UTILITIES (P U)

421. ELECTRIC UTILITIES (3)

## RUSSIAN (RUS)

401. STUDIES IN RUSSIAN LITERATURE (3-6)
425. PUSHKIN (3)
426. DOSTOEVSKI (3)
427. TOLSTOY (3)

## VETERINARY SCIENCE (V SC)

400. VETERINARY ANATOMY AND PHYSIOLOGY (3)
401. INFECTIOUS DISEASES OF DOMESTIC ANIMALS (2)
515. (Bact. 515). VIROLOGY (2-4) Rickettsial and viral agents parasitizing man, animals, and microorganisms. Prerequisite: Bact. 410.

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THE PENNSYLVANIA STATE UNIVERSITY  
*GRADUATE SCHOOL ANNOUNCEMENT*  
UNIVERSITY PARK, PENNSYLVANIA

THE  
PENNSYLVANIA  
STATE  
UNIVERSITY  
BULLETIN



1959-1960

GRADUATE  
SCHOOL  
ANNOUNCEMENT



OFFICE OF THE GRADUATE SCHOOL  
104 Willard Building



The post office address of The Pennsylvania State University is University Park, Pennsylvania, but the town in which the University is located is State College.



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UNIVERSITY PARK, PENNSYLVANIA

THE  
PENNSYLVANIA  
STATE  
UNIVERSITY

Graduate School  
Announcement  
1959-1960

UNIVERSITY PARK  
PENNSYLVANIA

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# Supplement to THE PENNSYLVANIA STATE UNIVERSITY BULLETIN

VOLUME LIII

January 15, 1959

NUMBER 1

As a result of recent official action the following items appearing in the 1959-1960 issue of the *Graduate School Announcement* have undergone major changes.

1. TUITION (See page 31) — Effective September 1959 fees were revised as follows:

## TUITION PAYABLE EACH SEMESTER:

### *Students registering for 12 or more credits:*

Pennsylvanians .....	\$240.00
Non-Pennsylvanians, on-campus studies .....	480.00
Non-Pennsylvanians, off-campus research (610) .....	240.00

### *Students registering for fewer than 12 credits:*

Pennsylvanians, per credit .....	20.00
Non-Pennsylvanians, on campus studies, per credit .....	40.00
Non-Pennsylvanians, off-campus research (610), per credit .....	20.00

*Vocational education courses* .....No change

### *Graduate assistants, fellows, and scholars*

*Health and welfare charge* ..... Charge abolished  
(Graduate assistants, fellows, and scholars are entitled to receive services at the University Health Center without payment of an additional charge.)

2. MASTER'S DEGREES (See pages 38 and 69) — Effective with the Fall Semester 1959 a new program leading to the professional degree Master of Business Administration will be offered.

This program is designed to develop advanced professional competence in the various fields of business administration and should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Science with a major in Business Administration. The six areas of specialization are: accounting, banking and finance, insurance and real estate, management, marketing, and transportation and trade.

The program requires a minimum of 36 graduate credits, of which at least 26 must be earned on the University Park Campus.

For admission a student who has taken his undergraduate work in the field of business administration will be expected to have completed courses in accounting, business law, business statistics, economics, finance, management, and marketing, but will be permitted to make up a limited number of deficiencies. A student who has had little or no training in business administration, but whose academic record is good, will be admitted with undergraduate deficiencies not to exceed 21 credits which can be made up while pursuing the graduate program, but without graduate credit. An applicant for admission who has insufficient course work in the arts and sciences will also be required to make up the deficiencies without graduate credit.



# GRADUATE CALENDAR

## *SPRING SEMESTER 1959*

### JANUARY 1959

- 28-31 Wednesday to Saturday—Spring Semester Registration
- 28-31 Wednesday to Saturday—Oral Examinations in Foreign Languages for Doctoral Candidates

### FEBRUARY

- 2 Monday—Spring Semester Classes Begin 8 a.m.
- 2 Monday—Last Date for Registering with Foreign Language Departments for Written Language Examinations
- 14 Saturday—Last Date for Students to Add Courses
- 19 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 28 Saturday—Last Date for Students to Drop Courses

### MARCH

- 2 Monday—Written Foreign Language Examinations for Doctoral Candidates 7 p.m.
- 14 Saturday—Last Date for Signing of Diploma Card and Payment of Thesis Binding Fee for June Graduates
- 19 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 25 Wednesday—Spring Recess Begins 11:50 a.m.

### APRIL

- 1 Wednesday—Spring Recess Ends 1:15 p.m.
- 16 Thursday—Graduate Faculty Meeting 4:10 p.m.

### MAY

- 9 Saturday—Last Date for a June Graduate to Deliver Doctoral Thesis to Committee
- 14 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 16 Saturday—Last Date for a June Graduate to Deliver Master's Thesis to Adviser
- 16 Saturday—Last Date for Final Oral Doctoral Examination for June Graduates
- 16 Saturday—Cap and Gown Fee Due 5:30 p.m.
- 23 Saturday—Spring Semester Classes End 11:50 a.m.
- 23 Saturday—Theses Due in Graduate School Office 12 noon
- 25 Monday—Spring Semester Examinations Begin 8 a.m.

### JUNE

- 2 Tuesday—Spring Semester Ends 5:30 p.m.
- 6 Saturday—Commencement Day



## SUMMER SESSIONS 1959

### JUNE 1959

- 8 Monday—Registration in a.m. for Inter-Session and First Six Weeks Session
- 8 Monday—Classes Begin 2 p.m.
- 10 Wednesday—Last Date for Inter-Session Students to Drop or Add Courses
- 15 Monday—Last Date for First Six Weeks Session Students to Drop or Add Courses
- 26 Friday—Inter-Session Ends 6:20 p.m.
- 29 Monday—Registration for Mid-Session
- 30 Tuesday—Mid-Session Classes Begin 8 a.m.
- 30 Tuesday—Oral Examinations in Foreign Languages for Doctoral Candidates and Registration for Written Examinations

### JULY

- 6 Monday—Last Date for Mid-Session Students to Drop or Add Courses
- 10 Friday—Last Date for an August Graduate to Deliver Doctoral Thesis to Committee
- 10 Friday—Last Date for Signing of Diploma Card and Payment of Thesis Binding Fee for August Graduates
- 17 Friday—Last Date for an August Graduate to Deliver Master's Thesis to Adviser
- 17 Friday—Last Date for Final Oral Doctoral Examination for August Graduates
- 17 Friday—First Six Weeks Session Ends 6:20 p.m.
- 18 Saturday—Cap and Gown Fee Due 5:30 p.m.
- 20 Monday—Registration in a.m. for Second Six Weeks Session
- 20 Monday—Second Six Weeks Session Classes Begin 2 p.m.
- 24 Friday—Theses Due in Graduate School Office 5 p.m.
- 27 Monday—Last Date for Second Six Weeks Students to Drop or Add Courses
- 27 Monday—Written Foreign Language Examinations for Doctoral Candidates 7 p.m.

### AUGUST

- 7 Friday—Mid-Session Ends 6:20 p.m.
- 7 Friday—Mid-Session Graduation Exercises 7 p.m.
- 10 Monday—Registration in a.m. for Post-Session
- 10 Monday—Post-Session Classes Begin 2 p.m.
- 12 Wednesday—Last Date for Post-Session Students to Drop or Add Courses
- 28 Friday—Post-Session and Second Six Weeks Session End 6:20 p.m.

## FALL SEMESTER 1959

### SEPTEMBER 1959

- 16-19 Wednesday to Saturday Noon—Fall Semester Registration
- 16-19 Wednesday to Saturday Noon—Oral Examinations in Foreign Languages for Doctoral Candidates
- 21 Monday—Fall Semester Classes Begin 8 a.m.

## OCTOBER

- 3 Saturday—Last Date for Students to Add Courses
- 12 Monday—Last Date for Registering with Foreign Language Departments for Written Language Examinations
- 15 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 17 Saturday—Last Date for Students to Drop Courses
- 31 Saturday—Last Date for Signing of Diploma Card and Payment of Thesis Binding Fee for January Graduates

## NOVEMBER

- 2 Monday—Written Foreign Language Examinations for Doctoral Candidates 7 p.m.
- 19 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 25 Wednesday—Thanksgiving Recess Begins 11:50 a.m.
- 30 Monday—Thanksgiving Recess Ends 8 a.m.

## DECEMBER

- 17 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 19 Saturday—Christmas Recess Begins 11:50 a.m.

## JANUARY 1960

- 2 Saturday—Last Date for a January Graduate to Deliver Doctoral Thesis to Committee
- 4 Monday—Christmas Recess Ends 8 a.m.
- 9 Saturday—Last Date for a January Graduate to Deliver Master's Thesis to Adviser
- 9 Saturday—Last Date for Final Oral Doctoral Examination for January Graduates
- 9 Saturday—Cap and Gown Fee Due 5:30 p.m.
- 16 Saturday—Theses Due in Graduate School Office 12 noon
- \*20 Wednesday—Fall Semester Classes End 9:50 p.m.
- 21 Thursday—Fall Semester Examinations Begin 8 a.m.
- 29 Friday—Fall Semester Ends 5:30 p.m.
- 31 Sunday—Fall Semester Graduation Exercises

## *SPRING SEMESTER 1960*

## FEBRUARY 1960

- 3-6 Wednesday to Saturday Noon—Spring Semester Registration
- 3-6 Wednesday to Saturday Noon—Oral Examinations in Foreign Languages for Doctoral Candidates
- 8 Monday—Spring Semester Classes Begin 8 a.m.
- 8 Monday—Last Date for Registering with Foreign Language Departments for Written Language Examinations
- 20 Saturday—Last Date for Students to Add Courses
- 25 Thursday—Graduate Faculty Meeting 4:10 p.m.

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\* On Monday, January 18, the classes shall be according to the Thursday schedule; on Tuesday, January 19, the classes shall be according to the Friday schedule; and on Wednesday, January 20, the morning classes will follow the Saturday schedule, and the afternoon classes will follow the normal Wednesday schedule.

## MARCH

- 5 Saturday—Last Date for Students to Drop Courses
- 7 Monday—Written Foreign Language Examinations for Doctoral Candidates 7 p.m.
- 19 Saturday—Last Date for Signing of Diploma Card and Payment of Thesis Binding Fee for June Graduates
- 24 Thursday—Graduate Faculty Meeting 4:10 p.m.

## APRIL

- 13 Wednesday—Spring Recess Begins 11:50 a.m.
- 20 Wednesday—Spring Recess Ends 1:15 p.m.
- 21 Thursday—Graduate Faculty Meeting 4:10 p.m.

## MAY

- 14 Saturday—Last Date for a June Graduate to Deliver Doctoral Thesis to Committee
- 19 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 21 Saturday—Last Date for a June Graduate to Deliver Master's Thesis to Adviser
- 21 Saturday—Last Date for Final Oral Doctoral Examination for June Graduates
- 21 Saturday—Cap and Gown Fee Due 5:30 p.m.
- 28 Saturday—Spring Semester Classes End 11:50 a.m.
- 28 Saturday—Theses Due in Graduate School Office 12 noon
- 30 Monday—Spring Semester Examinations Begin 8 a.m.

## JUNE

- 7 Tuesday—Spring Semester Ends 5:30 p.m.
- 11 Saturday—Spring Semester Graduation Exercises



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ERIC A. WALKER, Sc.D., LL.D., P.E.

*President of the University*

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<i>Director of Resident Instruction, College of Architecture</i>	

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FRANK A. JOY, B.S. (New Hampshire)	<i>Engineering Research</i>
LOUIS T. KARDOS, Ph.D. (Rutgers)	<i>Soil Technology</i>
MACKENZIE L. KEITH, Ph.D. (M.I.T.)	<i>Geochemistry</i>
PAUL M. KENDIG, Ph.D. (Penn State)	<i>Engineering Research</i>
CORLISS R. KINNEY, Ph.D. (Harvard)	<i>Fuel Technology</i>
PHILIP S. KLEIN, Ph.D. (Pennsylvania)	<i>American History</i>
HENRY W. KNERR, Ph.D. (Michigan)	<i>Physics</i>
R. RUPERT KOUNTZ, M.S. (Iowa), P.E.	<i>Sanitary Engineering</i>
HARRY L. KRALL, Ph.D. (Brown)	<i>Mathematics</i>
FRANKLIN B. KRAUSS, Ph.D. (Pennsylvania)	<i>Latin</i>
DAVID A. KRIBS, Ph.D. (Yale)	<i>Botany</i>
PAUL D. KRYNINE, Ph.D. (Yale)	<i>Petrology and Sedimentation</i>
OTIS E. LANCASTER, Ph.D. (Harvard), P.E.	<i>Engineering Education</i>
S. LEWIS LAND, Ph.D. (N.Y.U.)	<i>Industrial Education</i>
RUSSELL E. LARSON, Ph.D. (Minnesota)	<i>Horticulture</i>
JOHN D. LAWTHORP, M.A. (Columbia), D.Pd.	<i>Physical Education</i>
WAYNE A. LEE, Ph.D. (Cornell)	<i>Marketing</i>
WILLIAM M. LEPPLEY, Ph.D. (Penn State)	<i>Psychology</i>
LAURENT LESAGE, Ph.D. (Illinois)	<i>Romance Languages</i>
FRED H. LEWIS, Ph.D. (Cornell)	<i>Plant Pathology</i>
JESSE E. LIVINGSTON, Ph.D. (Missouri)	<i>Botany and Plant Pathology</i>
A. PAULINE LOCKLIN, M.A. (Illinois)	<i>English</i>
CHARLES M. LONG, D.Ed. (Colorado)	<i>Education</i>
GEORGE M. LOTT, M.D. (Colorado)	<i>Psychiatrist</i>
MIRIAM E. LOWENBERG, Ph.D. (Iowa)	<i>Foods and Nutrition</i>
VIKTOR LOWENFELD, Professor der Kunsterziehung (Vienna)	<i>Art Education</i>
ERNEST H. LUDWIG, Ph.D. (Pennsylvania)	<i>Bacteriology</i>
JOHN C. MAJOR, Ph.D. (Pennsylvania)	<i>English Composition</i>
FREDERICK B. MARBUT, Ph.D. (Harvard)	<i>Journalism</i>
PAUL H. MARGOLF, B.S. (Penn State)	<i>Poultry Husbandry</i>
JOSEPH MARIN, Ph.D. (Michigan), P.E.	<i>Engineering Mechanics</i>
JAMES W. MARKHAM, Ph.D. (Missouri)	<i>Journalism</i>

# PROFESSORS

JOHN W. MASTALERZ, Ph.D. (Cornell)	Floriculture
ROY P. MATELSKI, Ph.D. (Michigan State)	Soil Technology
WILLIAM G. MATHER, Ph.D. (Cornell)	Sociology
FREDERICK R. MATSON, Ph.D. (Michigan)	Archaeology
ARTHUR J. G. MAW, Ph.D. (Wisconsin)	Poultry Husbandry
EUGENE T. McDONALD, D.Ed. (Penn State)	Speech and Speech Education
DONALD G. MCGAREY, D.Ed. (Penn State)	Education
M. NELSON MCGEARY, Ph.D. (Columbia)	Political Science
DAVID H. MCKINLEY, M.A. (Penn State), LL.B.	Banking
CHESTER T. MCNERNEY, Ph.D. (Indiana)	Education
DOUGLASS S. MEAD, Ph.D. (Princeton)	English Literature
ROBERT P. MEAHL, M.S. (Purdue)	Ornamental Horticulture
JOHN R. MENTZER, Ph.D. (Ohio State)	Engineering Sciences
WOLFGANG E. MEYER, Dipl.Ing.M.E. (Hannover)	Mechanical Engineering
IRVING MICHELSON, Ph.D. (California Tech.)	Aeronautical Engineering
DELBERT C. MILLER, Ph.D. (Minnesota)	Sociology
E. WILLARD MILLER, Ph.D. (Ohio State)	Geography
FRANKLIN A. MILLER, Ph.D. (Pittsburgh)	Education
RUSSELL C. MILLER, Ph.D. (Cornell)	Agricultural and Biological Chemistry
WARREN W. MILLER, Ph.D. (California)	Chemistry
WILFORD R. MILLS, Ph.D. (Cornell)	Plant Pathology
DAVID R. MITCHELL, M.S. (Penn State), E.M., P.E.	Mining Engineering
MAURICE A. MOOK, Ph.D. (Pennsylvania)	Anthropology
WINONA L. MORGAN, Ph.D. (Minnesota)	Child Development and Family Relationships
JOHN A. MOURANT, Ph.D. (Chicago)	Philosophy
JAMES H. MOYER, D.Ed. (Columbia)	Education
ERWIN W. MÜLLER, Dr.Ing.habil. (Technical University, Berlin)	Physics
GEORGE E. MURPHY, D.Ed. (Stanford)	Education
ROBERT R. MURPHY, Ph.D. (Penn State)	Poultry Husbandry
H. BURTON MUSSER, B.S. (Penn State)	Agronomy
G. KENNETH NELSON, Ph.D. (Illinois), C.P.A.	Accounting
MARGARET A. NEUBER, M.A. (Columbia)	Education
HANS NEUBERGER, D.Sc. (Hamburg)	Meteorology
FRANK S. NEUSBAUM, M.A. (Penn State)	Theatre Arts
BENJAMIN W. NIEBEL, M.S. (Penn State), I.E., P.E.	Industrial Engineering
RALPH F. NIELSEN, Ph.D. (Nebraska)	Petroleum and Natural Gas Engineering
CLARENCE I. NOLL, Ph.D. (Penn State)	Chemistry
NEWELL A. NORTON, Ph.D. (Michigan)	Wood Utilization
THOMAS S. OAKWOOD, Ph.D. (Penn State)	Chemistry
MARTIN L. ODLAND, Ph.D. (Minnesota)	Olericulture
J. HARRIS OLEWINE, Ph.D. (Penn State)	Organic Chemistry
ROBERT T. OLIVER, Ph.D. (Wisconsin), LL.D.	Speech
GEORGE U. OPPEL, Dr.Ing. (Technical University, Munich)	Engineering Mechanics
ELBURT F. OSBORN, Ph.D. (California Tech.)	Geochemistry
MILTON S. OSBORNE, M.S. (Columbia), R.A.	Architecture
INA PADGETT, M.S. (Columbia)	Foods and Nutrition
HANS A. PANOFSKY, Ph.D. (California)	Meteorology
ROBERT B. PATRICK, D.Ed. (Columbia)	Education
LOUIS F. PECK, Ph.D. (Harvard)	English Composition
FRANK W. PEIKERT, M.S. (Iowa State)	Agricultural Engineering
RAYMOND PEPINSKY, Ph.D. (Chicago)	Physics

LAWRENCE J. PEREZ, M.C.E. (Brooklyn Polytech.), P.E.	Civil Engineering
CLARE W. PIERCE, Ph.D. (Cornell)	Agricultural Economics
GORDON H. PRITHAM, Ph.D. (Penn State)	Physiological Chemistry
ALFRED G. PUNDT, Ph.D. (Columbia)	European History
ELMER R. QUEER, M.S. (Penn State), P.E.	Engineering Research
DOROTHY QUIGGLE, Ph.D. (Penn State)	Chemistry and Chemical Engineering
JOHN R. RACKLEY, Ph.D. (George Peabody)	Education
STEPHEN M. RALEIGH, Ph.D. (Minnesota)	Agronomy
DAVID H. RANK, Ph.D. (Penn State), D.Sc.	Physics
JOSEPH G. RAYBACK, Ph.D. (Western Reserve)	American History
HAROLD J. READ, Ph.D. (Pennsylvania), P.E.	Physical Metallurgy
ARTHUR H. REEDE, M.A. (Penn State), D.Sc.	Economics
CALVIN G. REEN, M.S.E. (Michigan), P.E.	Civil Engineering
JAMES J. REID, Ph.D. (Wisconsin)	Bacteriology
J. W. CRANE REMALEY, Ph.D. (Pittsburgh)	Education
LOUIS A. RICHARDSON, M.S. (Penn State), P.E.	Architectural Engineering
A. CHESTER RICHER, Ph.D. (Penn State)	Soil Technology
CHAUNCEY O. RIDENOUR, M.A. (Penn State)	English Literature
JOHN D. RIDGE, Ph.D. (Chicago)	Mineral Economics
ARTHUR ROSE, Ph.D. (Cincinnati)	Chemical Engineering
CHARLES J. ROWLAND, M.B.A. (Northwestern), C.P.A.	Accounting
RUSTUM ROY, Ph.D. (Penn State)	Geochemistry
JOSEPH J. RUBIN, Ph.D. (Yale)	American Literature
DAVID W. RUSSELL, Ph.D. (Western Reserve)	Education
JOHN A. SAUER, Ph.D. (Cambridge)	Physics
ROGER B. SAYLOR, Ph.D. (Illinois)	Business Statistics
HAROLD K. SCHILLING, Ph.D. (Iowa), D.Sc.	Physics
CLAYTON H. SCHUG, M.A. (Ohio State)	Public Speaking
RALPH P. SEWARD, Ph.D. (Brown)	Chemistry
AMOS J. SHALER, Sc.D. (M.I.T.)	Metallurgy
WARD M. SHARP, Ph.D. (Washington U.)	Wildlife Management
ISADOR M. SHEFFER, Ph.D. (Harvard)	Mathematics
PHILIP A. SHELLEY, Ph.D. (Harvard)	German and Comparative Literature
SAMUEL SHULITS, M.S. (Michigan College of Mining and Technology)	Civil Engineering
EUGEN SKUDRZYK, Ph.D. (Berlin)	Engineering Research
ROBERT L. SLOBOD, Ph.D. (Northwestern)	Petroleum and Natural Gas Engineering
GRANT W. SMITH, Ph.D. (Minnesota)	Chemistry
KINSLEY R. SMITH, Ph.D. (Pennsylvania)	Psychology
WILLIAM M. SMITH, Jr., Ph.D. (Cornell)	Family Relationships
WILLIAM U. SNYDER, Ph.D. (Ohio State)	Psychology
NORMAN R. SPARKS, M.E. (Clarkson)	Mechanical Engineering
CHARLES M. SPEIDEL, M.S. (Penn State)	Physical Education
HOWARD B. SPRAGUE, Ph.D. (Rutgers)	Agronomy
VANCE G. SPRAGUE, Ph.D. (Wisconsin)	Agronomy
EARL B. STAVELY, E.E. (Penn State)	Electrical Engineering
GLENN Z. STEVENS, Ph.D. (Minnesota)	Agricultural Education
ROBERT W. STONE, Ph.D. (Iowa State)	Bacteriology
RANDALL S. STOUT, Ph.D. (Pittsburgh)	Economics
EARL P. STRONG, Ed.D. (N.Y.U.)	Management
JOSEPH T. SULLIVAN, Ph.D. (Purdue)	Phytochemistry
SHIOU-CHUAN SUN, Sc.D. (M.I.T.)	Mineral Preparation



## PROFESSORS

A. BRUCE SUTHERLAND, Ph.D. (Pennsylvania)	<i>English Literature</i>
FRANK M. SWARTZ, Ph.D. (Johns Hopkins)	<i>Paleontology</i>
RAYMOND W. SWIFT, Ph.D. (Rochester)	<i>Animal Nutrition</i>
ROBERT W. TAFT, JR., Ph.D. (Ohio State)	<i>Chemistry</i>
SHELDON C. TANNER, M.A. (Utah)	<i>Business Law</i>
HAROLD I. TARPLEY, M.S. (Illinois), P.E.	<i>Electrical Engineering</i>
FLORENCE E. TAYLOR, D.Ed. (Columbia)	<i>Elementary Education</i>
WILLA C. TAYLOR, M.A. (N.Y.U.)	<i>Music and Music Education</i>
GLENN N. THIEL, M.Ed. (Penn State)	<i>Physical Education</i>
S. EARL THOMPSON, D.Ed. (Illinois)	<i>Hotel and Institution Administration</i>
GEORGE L. THUERING, M.S. (Penn State), M.E., P.E.	<i>Industrial Engineering</i>
HARRISON M. TIETZ, Ph.D. (Massachusetts)	<i>Anatomy and Physiology</i>
HOWARD O. TRIEBOLD, Ph.D. (Minnesota)	<i>Agricultural and Biological Chemistry</i>
O. FRANK TUTTLE, Ph.D. (M.I.T.)	<i>Geochemistry</i>
ABRAM W. VANDERMEER, Ph.D. (Chicago)	<i>Education</i>
EDWARD B. VANORMER, Ph.D. (Columbia)	<i>Psychology</i>
DOROTHY H. VEON, Ed.D. (Columbia)	<i>Education</i>
ROBERT K. VIERCK, M.S. (Iowa), P.E.	<i>Engineering Mechanics</i>
HERBERT A. WAHL, Ph.D. (Penn State)	<i>Botany</i>
PHILIP L. WALKER, JR., Ph.D. (Penn State)	<i>Fuel Technology</i>
JOHN B. WASHKO, Ph.D. (Wisconsin)	<i>Agronomy</i>
R. HADLY WATERS, Ph.D. (Pennsylvania)	<i>Transportation</i>
ARTHUR H. WAYNICK, Sc.D. (Harvard)	<i>Electrical Engineering</i>
PALMER C. WEAVER, Ph.D. (Columbia)	<i>Education</i>
WAYNE WEBB, Ph.D. (Iowa)	<i>Physics</i>
ARTHUR M. WELLINGTON, M.A. (Ohio State)	<i>Counselor Education</i>
WILLIAM L. WERNER, M.A. (Penn State)	<i>American Literature</i>
CLIFFORD C. WERNHAM, Ph.D. (Cornell)	<i>Plant Pathology</i>
WOLDEMAR WEYL, Dr.Ing. (Aachen)	<i>Glass Technology</i>
RALPH H. WHERRY, M.A. (Penn State), C.L.U.	<i>Insurance</i>
BENJAMIN A. WHISLER, Sc.D. (Harvard), P.E.	<i>Civil Engineering</i>
MARSH W. WHITE, Ph.D. (Penn State), Sc.D.	<i>Physics</i>
WALLACE E. WHITE, Ph.D. (Yale)	<i>Wood Technology</i>
DELPHA E. WIESENDANGER, M.S. (Cornell)	<i>Home Management and Housing</i>
MARY L. WILLARD, Ph.D. (Cornell)	<i>Chemistry</i>
PAUL S. WILLIAMS, M.S. (Penn State)	<i>Dairy Production</i>
EVA D. WILSON, Ph.D. (Chicago)	<i>Foods and Nutrition</i>
HAROLD K. WILSON, Ph.D. (Illinois)	<i>Agronomy</i>
GEORGE F. WISLICENUS, Ph.D. (California Tech.), P.E.	<i>Aeronautical Engineering</i>
HAROLD P. ZELKO, M.A. (Ohio State), LL.B.	<i>Speech</i>
EDWIN W. ZOLLER, B.A., (Penn State)	<i>Art</i>

## ASSOCIATE PROFESSORS

EDWARD ABRAMSON, A.M. (Pennsylvania)	<i>Sociology</i>
EUGENE ACKERMAN, Ph.D. (Wisconsin)	<i>Physics</i>
MARY BROWN ALLGOOD, M.S. (Iowa State)	<i>Home Equipment and Commercial Consumer Services</i>
ADAM ANTHONY, Ph.D. (Chicago)	<i>Zoology</i>
RALPH E. ARMINGTON, Ph.D. (Pittsburgh), E.E., P.E.	<i>Electrical Engineering</i>
RALPH G. ASCAH, Ph.D. (N.Y.U.)	<i>Chemistry</i>

# ASSOCIATE PROFESSORS

VERNON V. ASPATURIAN, Ph.D. (U.C.L.A.)	Political Science
RAYMOND G. D. AYOUB, Ph.D. (Illinois)	Mathematics
FRANCIS A. BABIONE, Ph.D. (Ohio State)	Marketing
GEORGE P. BARRON, Jr., Ph.D. (Penn State)	Animal Nutrition
HOWARD D. BARTLETT, M.S. (Maine)	Agricultural Engineering
JAMES B. BARTOO, Ph.D. (Iowa)	Mathematics
RONALD A. BARTOO, M.F. (Yale)	Forestry
CARL A. BAUER, Ph.D. (Harvard)	Astronomy
SAMUEL P. BAYARD, A.M. (Harvard)	English Composition
KENNETH R. BEITTEL, D.Ed. (Penn State)	Art Education
SIMON BELASCO, Ph.D. (Pennsylvania)	Romance Languages
ANDREW A. BENSON, Ph.D. (California Tech.)	Agricultural and Biological Chemistry
ASA J. BERLIN, Ph.D. (Northwestern)	Speech Education
ALFRED K. BLACKADAR, Ph.D. (N.Y.U.)	Meteorology
CONVERSE H. BLANCHARD, Ph.D. (Wisconsin)	Physics
GERALD R. BOSCH, Ph.D. (Michigan State)	Education
SIDNEY A. BOWHILL, Ph.D. (Cambridge)	Electrical Engineering
JOHN S. BOYLE, Ph.D. (Wisconsin)	Plant Pathology
J. NORTON BRENNAN, Ph.D. (Penn State)	Engineering Mechanics
NICHOLAS M. BRENTIN, M.A. (Penn State)	Romance Languages
LEO A. BRESSLER, Ph.D. (Pennsylvania)	English Composition
ARTHUR D. BRICKMAN, M.S. (Penn State), Mech.E.	Mechanical Engineering
JOSEPH H. BRITTON, Ph.D. (Chicago)	Child Development and Family Relationships
EMORY J. BROWN, Ph.D. (Michigan State)	Rural Sociology and Agricultural Extension
IRA V. BROWN, Ph.D. (Harvard)	American History
JOHN L. BROWN, Jr., Ph.D. (Brown)	Engineering Research
ROBERT S. BRUBAKER, Ph.D. (Illinois)	Speech Science
ROY C. BUCK, Ph.D. (Minnesota)	Rural Sociology
EMIL J. BURCIK, Ph.D. (California Tech.)	Petroleum and Natural Gas Engineering
CLYDE R. BURNETT, Ph.D. (Wisconsin)	Physics
EDWARD G. BUSS, Ph.D. (Purdue)	Poultry Husbandry
WILLIAM T. BUTZ, Ph.D. (Penn State)	Agricultural Economics
W. PAUL CAMPBELL, D.Ed. (Penn State)	Music Education
FLOYD L. CARNAHAN, Ph.D. (Northwestern)	Chemical Engineering
ELTON S. CARTER, Ph.D. (Northwestern)	Speech
GEORGE E. CEIGA, B.Mus. (American Conservatory)	Music
WILLIAM V. CHANDLER, Ph.D. (Ohio State)	Soil Technology
HUGH H. CHAPMAN, Jr., Ph.D. (Harvard)	Romance Languages
MICHAEL CHIAPPETTA, Ph.D. (Michigan)	Education
HENRY H. CHISMAN, M.F. (Duke)	Forestry
ROBERT G. COCHRAN, Ph.D. (Penn State)	Nuclear Engineering
JOSEPH J. COMER, M.S. (Penn State)	Mineral Sciences
EDWIN L. COOPER, Ph.D. (Michigan)	Zoology
CLYDE G. CORLE, D.Ed. (Cincinnati)	Education
WILLIAM CRAIG, Ph.D. (Harvard)	Mathematics
NORMAN C. DENO, Ph.D. (Ohio State)	Chemistry
JOHN A. DeNOVO, Ph.D. (Yale)	American History
CHARLES C. DiILIO, M.S. (Penn State), P.E.	Mechanical Engineering
JOSEPH A. DIXON, Ph.D. (Penn State)	Chemistry
LOUIS DUPREE, Ph.D. (Harvard)	Anthropology
CHARLES L. FERGUS, Ph.D. (Penn State)	Botany and Plant Pathology

## ASSOCIATE PROFESSORS

ILINE FIFE, Ph.D. (Louisiana State)	Speech
HARRY C. FINK, Ph.D. (Iowa State)	Plant Pathology
KATHERINE H. FISHER, Ph.D. (Penn State)	Foods and Nutrition
EDWIN R. FITZGERALD, Ph.D. (Wisconsin)	Physics
ROBERT J. FLIPSE, Ph.D. (Michigan State)	Dairy Science
H. SEYMOUR FOWLER, Ph.D. (Cornell)	Nature and Science Education
JOHN C. FREY, Ph.D. (Iowa State)	Land Economics
JAMES V. FRICK, Ph.D. (Iowa)	Speech
ALINE H. FRINK, Ph.D. (Chicago)	Mathematics
JAMES J. FRITZ, Ph.D. (California)	Chemistry
MARY E. FUQUA, Ph.D. (Ohio State)	Foods and Nutrition
HELEN S. GALBRAITH, M.A. (Penn State)	Art
ROBERT F. GENTRY, Ph.D. (Michigan State)	Veterinary Science
LEON GORLOW, Ph.D. (Columbia)	Psychology
JOSEPH H. GRAHAM, Ph.D. (North Carolina State)	Plant Pathology
PHYLLIS R. GRIESS, Ph.D. (Penn State)	Geography
GEORGE M. GUTHRIE, Ph.D. (Minnesota)	Psychology
CHARLES G. HAAS, Jr., Ph.D. (Chicago)	Chemistry
EDGAR B. HALE, Ph.D. (Chicago)	Animal Behavior
DONALD E. HARDENBERGH, M.S. (Penn State)	Engineering Mechanics
JOHN R. HAYES, Ph.D. (Penn State)	Chemistry
CARROLL E. HEIST, Ph.D. (Illinois)	Bacteriology
RODNEY E. HERSH, M.S. (Penn State)	Chemical Engineering
E. ELIZABETH HESTER, Ph.D. (Cornell)	Foods and Nutrition
ROLAND L. HICKS, D.Ed. (Penn State)	Journalism
ELIZABETH C. HILLIER, Ph.D. (Ohio State)	Home Economics Education
CLIFFORD B. HOLT, JR., M.S. (Penn State), P.E.	Electrical Engineering
ALBERT H. HOLTZINGER, Ph.D. (Penn State)	Chemistry
PAUL D. HOLTZMAN, Ph.D. (Southern California)	Speech
CHARLES L. HOSLER, Jr., Ph.D. (Penn State)	Meteorology
L. AILEEN HOSTINSKY, Ph.D. (Illinois)	Mathematics
ALIDA S. HOTCHKISS, Ph.D. (Cornell)	Home Management and Family Economics
LING-WEN HU, Ph.D. (Penn State)	Engineering Mechanics
LYMAN C. HUNT, JR., D.Ed. (Syracuse)	Education
HARRY K. HUTTON, D.Ed. (Penn State)	Education
HENRY W. JOHNSTONE, JR., Ph.D. (Harvard)	Philosophy
JENNINGS H. JONES, Ph.D. (Penn State)	Chemistry
JOSEPH JORDAN, Ph.D. (Hebrew University, Jerusalem)	Chemistry
THEODORE K. KARHAN, M.Ed. (Penn State)	Music and Music Education
JACOB J. KAUFMAN, Ph.D. (Columbia)	Economics
ROBERT W. KAUTZ, Ph.D. (Indiana)	Business Statistics
EARL M. KESLER, Ph.D. (Penn State)	Dairy Science
E. ERWIN KLAUS, Ph.D. (Penn State)	Petroleum Chemistry
LEON R. KNEEBONE, Ph.D. (Penn State)	Botany and Plant Pathology
BORIS J. KOCHANOWSKY, Dr.Ing. (Clausthal)	Mining Engineering
CHARLES F. LEEDCKER, Ph.D. (Penn State)	Political Science
ARTHUR O. LEWIS, JR., Ph.D. (Penn State)	English Literature
EUGENE S. LINDSTROM, Ph.D. (Wisconsin)	Bacteriology
MILDRED A. LUCEY, Ph.D. (N.Y.U.)	Physical Education
M. FRANK MALLETTE, Ph.D. (Columbia)	Agricultural and Biological Chemistry
E. ORTH MALOTT, Ph.D. (Northwestern)	Finance
VACLAV MARES, Ph.D. (Charles University, Prague)	Economics



## ASSOCIATE PROFESSORS

CHARLES R. MARSH, M.S. (Illinois)	<i>Electrical Engineering</i>
WILLIAM H. MARTIN, Ph.D. (Harvard)	<i>Economics</i>
WILL E. MASON, Ph.D. (Princeton)	<i>Economics</i>
EDWARD L. MATIL, D.Ed. (Penn State)	<i>Art Education</i>
ROBERT H. McALEXANDER, Ph.D. (Iowa State)	<i>Farm Management</i>
ROBERT H. McCORMICK, M.S. (Penn State)	<i>Chemical Engineering</i>
EVERETT R. McLAUGHLIN, M.S. (Penn State), P.E.	<i>Engineering Research</i>
NEIL A. McNALL, Ph.D. (Cornell)	<i>American History</i>
MALCOLM C. McQUARRIE, Sc.D. (M.I.T.)	<i>Ceramic Technology</i>
JEANETTE MOLLOY, M.A. (Columbia)	<i>Elementary Education (part-time)</i>
J. HERBERT MOORE, M.S. (Penn State), P.E.	<i>Civil Engineering</i>
ARNULF I. MUAN, Ph.D. (Penn State)	<i>Metallurgy</i>
ROBERT K. MURRAY, Ph.D. (Ohio State)	<i>American History</i>
EUGENE A. MYERS, Ph.D. (Pittsburgh)	<i>Economics</i>
VERNON W. MYERS, Ph.D. (Yale)	<i>Physics</i>
WILLIAM T. NEARN, D.For. (Yale)	<i>Wood Utilization</i>
HAROLD E. NELSON, Ph.D. (Iowa)	<i>Speech</i>
MONROE NEWMAN, Ph.D. (Illinois)	<i>Economics</i>
FRANCENA L. NOLAN, Ph.D. (Penn State)	<i>Rural Sociology</i>
EDWIN P. NYE, M.S. (Harvard), P.E.	<i>Mechanical Engineering</i>
YOSHIHARU OKAYA, D.Sc. (Osaka)	<i>Physics</i>
GILMA M. OLSON, M.S. (Minnesota)	<i>Foods and Nutrition</i>
HOWARD B. PALMER, Ph.D. (Wisconsin)	<i>Fuel Technology</i>
LESLIE M. PAPE, Ph.D. (Chicago)	<i>Philosophy</i>
JEROME K. PASTO, Ph.D. (Cornell)	<i>Farm Management</i>
STUART PATTON, Ph.D. (Ohio State)	<i>Dairy Science</i>
DONALD S. PEARSON, M.S. (Case Institute of Technology), P.E.	
NORMAN C. PENDERED, D.Ed. (Penn State)	<i>Electrical Engineering</i>
ROBERT P. PFEIFER, Ph.D. (Illinois)	<i>Industrial Arts Education</i>
RUTH L. PIKE, Ph.D. (Chicago)	<i>Agronomy</i>
WILLIAM S. RAY, Ph.D. (Maryland)	<i>Foods and Nutrition</i>
ROBERT R. REED, Jr., Ph.D. (Columbia)	<i>Psychology</i>
ROBERT D. REIFSNEIDER, M.A. (Michigan)	<i>English Composition</i>
SARA A. RHUE, Ph.D. (Iowa)	<i>Theatre Arts</i>
NEAL RIEMER, Ph.D. (Harvard)	<i>Education</i>
C. MARSHALL RITTER, Ph.D. (Ohio State)	<i>Political Science</i>
H. DAVID RIX, Ph.D. (Princeton)	<i>Pomology</i>
ALLAN L. RODGERS, Ph.D. (Wisconsin)	<i>Physics</i>
WILLIAM J. ROSS, Ph.D. (New Zealand)	<i>Geography</i>
LÉON S. ROUDIEZ, Ph.D. (Columbia)	<i>Electrical Engineering</i>
RICHARD O. ROWLANDS, M.Sc. (Wales)	<i>Romance Languages</i>
CHARLES W. RUTSCHKY, Ph.D. (Cornell)	<i>Electrical Engineering</i>
JOHN J. SCHANZ, Jr., Ph.D. (Penn State)	<i>Entomology</i>
JOHN M. SCHEMPF, Ph.D. (Cornell)	<i>Mineral Economics</i>
ROBERT SCHOLTEN, Ph.D. (Michigan)	<i>Chemistry</i>
PAUL E. SHIELDS, M.S. (Pittsburgh), E.E., P.E.	<i>Petroleum Geology</i>
ALBERTA E. SIEGEL, Ph.D. (Stanford)	<i>Electrical Engineering</i>
SIDNEY SIEGEL, Ph.D. (Stanford)	<i>Child Development</i>
BRUCE M. SIEGENTHALER, Ph.D. (Michigan)	<i>Psychology</i>
RUTH C. SILVA, Ph.D. (Michigan)	<i>Clinical Speech</i>
PHILIP S. SKELL, Ph.D. (Duke)	<i>Political Science</i>
	<i>Chemistry</i>

## ASSOCIATE PROFESSORS

ALEC J. SLIVINSKE, Ph.D. (Virginia)	Psychology
CYRIL B. SMITH, Ph.D. (Penn State)	Plant Nutrition
JOSEPH V. SMITH, Ph.D. (Cambridge)	Mineralogy
WARREN S. SMITH, M.A. (Iowa)	Theatre Arts
LEO H. SOMMER, Ph.D. (Penn State)	Chemistry
WILLIAM SPACKMAN, JR., Ph.D. (Harvard)	Paleobotany
C. DREW STAHL, Ph.D. (Penn State)	Petroleum and Natural Gas Engineering
F. BRISCOE STEPHENS, Ph.D. (Penn State)	Meteorology
RICHARD G. STONER, Ph.D. (Princeton)	Physics
WERNER F. STRIEDIECK, Ph.D. (Michigan)	German
EDWARD C. THADEN, D.U.P. (Paris)	European History
DENO G. THEVAOS, Ed.D. (Columbia)	Psychology
GERALD M. TORKELSON, D.Ed. (Penn State)	Visual Education
CLARENCE E. TROTTER, Ph.D. (Minnesota)	Marketing
LOREN D. TUKEY, Ph.D. (Ohio State)	Pomology
WALTER H. WALTERS, Ph.D. (Western Reserve)	Theatre Arts
HAROLD V. WALTON, M.S. (Penn State)	Agricultural Engineering
THOMAS WARTIK, Ph.D. (Chicago)	Chemistry
GEORGE H. WATROUS, JR., Ph.D. (Penn State)	Dairy Manufacturing
ROBERT L. WEBER, Ph.D. (Penn State)	Physics
WINSTON R. WEISMAN, Ph.D. (Ohio State)	History of Art and Architecture
FREDERICK L. WERNSTEDT, Ph.D. (U.C.L.A.)	Geography
FRANCIS L. WHALEY, Ph.D. (Michigan)	Psychology
THOMAS A. WIGGINS, Ph.D. (Penn State)	Physics
EDWIN T. WILLIAMS, Ph.D. (Penn State)	Chemical Engineering
MERRILL WOOD, M.S. (Penn State)	Zoology
HAROLD D. WRIGHT, Ph.D. (Columbia)	Mineralogy
JAMES E. WRIGHT, Ph.D. (Cornell)	Genetics
KELLY YEATON, M.A. (Washington)	Theatre Arts
LEONARD N. ZIMMERMAN, Ph.D. (Cornell)	Bacteriology
HARRY D. ZOOK, Ph.D. (Penn State)	Chemistry
GEORGE S. ZORETICH, M.A. (Penn State)	Art

## ASSISTANT PROFESSORS

JEFFERSON D. ASHBY, Ph.D. (Penn State)	Psychology
BARKEV Y. BAKAMJIAN, Ph.D. (Columbia)	Physics
ROBERT V. BAUER, Ph.D. (Illinois)	English Literature
JOHN E. BENSON, Ph.D. (Princeton)	Chemistry
LUTHER T. BISSEY, M.S. (Penn State)	Petroleum and Natural Gas Engineering
DONALD W. BLEZNICK, Ph.D. (Columbia)	Romance Languages
JAMES R. BLOOM, Ph.D. (Wisconsin)	Plant Pathology
BARRY S. BRINSMAID, M.A. (Columbia)	Music
C. WAYNE BURNHAM, Ph.D. (California Tech.)	Economic Geology
H. BRUCE BYLUND, Ph.D. (Penn State)	Rural Sociology
LESTER E. CASIDA, JR., Ph.D. (Wisconsin)	Bacteriology
STUART H. CHAMBERLAIN, M.S. (Michigan State)	Mechanical Engineering
RICHARD W. CLEVELAND, Ph.D. (California)	Agronomy
H. TREVOR COLBOURN, Ph.D. (Johns Hopkins)	History
JAMES H. COPP, Ph.D. (Wisconsin)	Rural Sociology
HOUSTON B. COUCH, Ph.D. (California)	Plant Pathology

# ASSISTANT PROFESSORS

LLOYD A. CURRIE, Ph.D. (Chicago)	Chemistry
HOLLE G. DEBOER, M.A. (Colorado State College of Education)	Public Speaking
DOUGLAS J. DONAHUE, Ph.D. (Wisconsin)	Physics
JOHN P. DRISCOLL, Ph.D. (Penn State)	Education
CARL C. FAITH, Ph.D. (Purdue)	Mathematics
FREDERICK C. FLIEGEL, Ph.D. (Wisconsin)	Rural Sociology
DONALD H. FORD, Ph.D. (Penn State)	Psychology
GEORGE J. FRITZ, Ph.D. (Purdue)	Botany
NICHOLAS FUSCHILLO, Ph.D. (Leeds)	Physics
PAUL C. GILMORE, Dr.Math. (Amsterdam)	Mathematics
RICHARD E. GLICK, Ph.D. (California)	Chemistry
LIONEL GOODMAN, Ph.D. (Iowa State)	Chemistry
ROBERT W. GREEN, Ph.D. (Iowa)	History
PAUL GRUN, Ph.D. (Cornell)	Genetics
LEONARD F. HERZOG, Ph.D. (M.I.T.)	Geophysics
HENRY HIZ, Ph.D. (Harvard)	Mathematics
ARNE W. HOVIN, Ph.D. (U.C.L.A.)	Genetics
GEORGE R. HUDSON, Ed.D. (Columbia)	Education
DOUGLAS N. JACKSON, JR., Ph.D. (Purdue)	Psychology
BERNARD R. JERMAN, Ph.D. (Ohio State)	English Literature
RICHARD N. JORGENSEN, D.For. (Yale)	Wood Technology
PHILIP G. KEENEY, Ph.D. (Penn State)	Dairy Science
ANTON J. KOVAR, Ph.D. (Rome)	Botany
DONALD T. LAIRD, Ph.D. (Penn State)	Electrical Engineering
LAURENCE H. LATTMAN, Ph.D. (Cincinnati)	Geomorphology
JOSEPH T. LAW, M.A. (Wisconsin)	Political Science
LUKE T. LEE, Ph.D. (Fletcher School of Law and Diplomacy)	Political Science
MARY LISTER, Ph.D. (London)	Mathematics
WALLIS A. LLOYD, Ph.D. (Minnesota)	Chemical Engineering
JOHN R. LOTZ, Ph.D. (Penn State)	Chemistry
HAROLD L. LOVELL, Ph.D. (Penn State)	Mineral Sciences
LAWRENCE F. MARRIOTT, Ph.D. (Wisconsin)	Soil Technology
T. KING MCCUBBIN, JR., Ph.D. (Johns Hopkins)	Physics
EDMUND V. MECH, Ph.D. (Indiana)	Psychology
DONALD F. MITCHELL, Ph.D. (U.C.L.A.)	Genetics
E. JAMES MOORE, Ph.D. (Michigan)	Geophysics
J. MITCHELL MORSE, Ph.D. (Penn State)	English Composition
GERALD M. MOSER, D.U.P. (Paris)	Romance Languages
WERNER J. MUELLER, Dr.Sc.Tech. (Swiss Fed. Inst. of Tech.)	Poultry Husbandry
GEORGE R. MURRAY, Ph.D. (M.I.T.)	Chemistry
JOHN B. NESBITT, Sc.D. (M.I.T.)	Civil Engineering
RICHARD P. NICKELSEN, Ph.D. (Johns Hopkins)	Geology
ROBERT S. NOVOSAD, Ph.D. (Chicago)	Mathematics
EUGENE K. OXHANDLER, D.Ed. (Columbia)	Audio-Visual Education
WILLIAM J. PAGE, Ed.D. (Temple)	Education
ELLEN V. PIERS, Ph.D. (George Peabody)	Psychology
JOHN E. PIXTON, JR., Ph.D. (Chicago)	History
THEODORE S. POLANSKY, Ph.D. (Penn State)	Fuel Technology
BERNARD L. POLLACK, Ph.D. (Penn State)	Plant Breeding
WILLIAM W. PRATT, Ph.D. (Iowa State)	Physics
MARGARET C. RAABE, M.S. (Penn State)	Clinical Speech and Speech Education
GUY E. RINDONE, Ph.D. (Penn State)	Ceramic Technology



## ASSISTANT PROFESSORS

DONALD P. SATCHELL, Ph.D. (North Carolina State)	<i>Soil Technology</i>
MARTIN W. SCHEIN, Sc.D. (Johns Hopkins)	<i>Animal Behavior</i>
RICHARD D. SCHEIN, Ph.D. (California)	<i>Plant Pathology</i>
ROBERT F. SCHMALZ, A.M. (Harvard)	<i>Geology</i>
ERWIN R. SCHMERLING, Ph.D. (Cambridge)	<i>Electrical Engineering</i>
MAURICE SHAMMA, Ph.D. (Wisconsin)	<i>Chemistry</i>
JAMES W. SHIGLEY, Ph.D. (Penn State)	<i>Agricultural and Biological Chemistry</i>
THOMAS SMYTH, Jr., Ph.D. (Johns Hopkins)	<i>Entomology</i>
FRANCIS J. SORAUF, Ph.D. (Wisconsin)	<i>Political Science</i>
WILLIAM A. STEELE, Ph.D. (Washington)	<i>Chemistry</i>
ROBERT E. STOVER, Ph.D. (Penn State)	<i>Psychology</i>
H. TRACY STURCKEN, Ph.D. (North Carolina)	<i>Romance Languages</i>
JAMES TAMMEN, Ph.D. (California)	<i>Plant Pathology</i>
GEORGE A. THEODORSON, Ph.D. (Cornell)	<i>Sociology</i>
CHARLES P. THORNTON, Ph.D. (Yale)	<i>Petrography</i>
HUGH B. URBAN, Ph.D. (Penn State)	<i>Psychology</i>
J. BRUCE WAGNER, Jr., Ph.D. (Virginia)	<i>Metallurgy</i>
DARRELL E. WALKER, Ph.D. (California)	<i>Plant Breeding</i>
SAMUEL F. WILL, Jr., Ph.D. (Yale)	<i>Classical Languages</i>
ROLF G. WINTER, D.Sc. (Carnegie Tech.)	<i>Physics</i>
ARTHUR E. WOODWARD, Ph.D. (Brooklyn Polytech.)	<i>Chemistry</i>
RICHARD N. WORK, Ph.D. (Cornell)	<i>Physics</i>
PETER J. WYLLIE, Ph.D. (St. Andrew's)	<i>Geochemistry</i>

## OTHER MEMBERS OF THE GRADUATE FACULTY

JOSEPH ALESSANDRO, D.Ed. (Penn State)	<i>Education</i>
CHRISTINE W. AYOUB, Ph.D. (Yale)	<i>Mathematics</i>
PAUL T. BAKER, Ph.D. (Harvard)	<i>Anthropology</i>
RICHARD M. COLWELL, Ph.D. (Massachusetts)	<i>Accounting</i>
LESLIE P. GREENHILL, B. Com. (Melbourne)	<i>Academic Research and Services</i>
WARREN W. HASSLER, Jr., Ph.D. (Johns Hopkins)	<i>History</i>
HELEN D. HILL, Ph.D. (Penn State)	<i>Geneticist, U. S. Regional Pasture Research Laboratory</i>
NORMAN K. HOOVER, D.Ed. (Penn State)	<i>Agricultural Education</i>
ROBERT W. HOUSE, M.S. (Ohio U.)	<i>Electrical Engineering</i>
KENNETH W. HYLBERT, D.Ed. (Penn State)	<i>Rehabilitation Counseling</i>
OSCAR A. KIMMEL, M.S. (Penn State)	<i>Farm Mechanics</i>
GERHARD O. W. KREMP, Dr.rer.nat. (Posen)	<i>Geology</i>
CARL R. MOSS, M.B.A. (Harvard)	<i>Industrial Engineering</i>
AMOS E. NEYHART, M.S. (Penn State)	<i>Institute of Public Safety</i>
ROBERT M. POCKRASS, M.S. (Illinois)	<i>Journalism</i>
CLARK C. SPENCE, Ph.D. (Minnesota)	<i>History</i>
DONALD B. SWEGAN, D.Ed. (Penn State)	<i>Physical Education</i>
WALTER F. WESTERFELD, M.S. (Penn State)	<i>Botany</i>
EUGENE G. WILLIAMS, Ph.D. (Penn State)	<i>Geology</i>
MARTIN L. ZEIGLER, Ph.D. (Penn State)	<i>Division of Counseling</i>

GENERAL  
INFORMATION





## GENERAL INFORMATION

**G**RADUATE WORK at The Pennsylvania State University was first offered in 1862 when two graduate students were in residence. It was given more formal recognition in 1864 by the establishment of a "course for Graduates" designed for students who, after receiving the degree of Bachelor of Scientific Agriculture, wished to do advanced work leading to the degree of Master of Scientific Agriculture. For some time there were few graduate students, and graduate instruction was relatively unorganized. Later a committee of the University Senate was given the responsibility of establishing standards and regulations governing graduate work and the granting of advanced degrees. The Graduate School was organized in 1922. Until this time only masters' degrees and certain technical degrees had been conferred. In 1924, the Board of Trustees authorized the granting of the degree of Doctor of Philosophy. Still later other degrees were approved.

The faculty of the Graduate School consists of the President and certain other general administrative officers of the University, the Deans, the Librarian, the heads of departments, and those members of the instructional staff who have been authorized by the proper agencies of the Graduate School to offer graduate courses and supervise research leading to theses. It controls all academic matters pertaining to the Graduate School, subject to review by the University Senate.

The Graduate faculty has approximately 625 members. Graduate student enrollment was about 2000 per semester in 1957-58 and about 2800 during the summer of 1958. The number of advanced degrees conferred in 1957-58 was 711, of which 126 were doctorates.

## PROCEDURES AND REGULATIONS

A student is expected to assume full responsibility for knowing the regulations and pertinent procedures of the Graduate School as set forth in the *Graduate School Announcement*, the *Manual for Graduate Students*, and the *Thesis Information Bulletin*, and for meeting the standards and requirements expressed by these regulations. The *Manual*, which is available to a student after he has been admitted, sets forth in more detail the procedures governing registration, changes in program, and graduation, and gives other information about the Graduate School which is useful to graduate students. Every student should secure a copy of this manual from the Dean's office as soon after admission as possible.

**ADMISSION**—An applicant for admission to the Graduate School should understand that graduate work is not an extension of undergraduate work. It operates at a definitely higher level, demands scholarship of a high order, and emphasizes research and creativity. It involves a minimum of formal requirements and regulations, and a maximum of student initiative and responsibility.

A student does not become a graduate student merely by enrolling for advanced courses after having received a baccalaureate degree. Formal admission to the Graduate School is required. Credits earned before admission cannot be applied to meet degree requirements at a later date even though admission may have been granted in the meantime.

Admission is granted by the Dean of the Graduate School after approval of the application for admission by the department in which the student plans to do his major work. Blanks to be used in making formal application for admission can be

## ADMISSION

obtained from the Graduate School office. With his application each student should present the names of two persons who are well qualified to evaluate his ability for graduate work in the field of his choice, to whom departments may write. In general, a student may begin his graduate work in fall, spring, or summer.

An applicant for admission should provide complete credentials, in duplicate, sent directly from other institutions to the Dean of the Graduate School at least six weeks prior to the opening of the session in which he plans to begin his graduate program. If the applicant has attended more than one institution, two official transcripts of the work covered at each institution are required. This applies to the complete academic record, both undergraduate and graduate.

An applicant who has done considerable high quality graduate work in a graduate school known to maintain high standards will be considered on the basis of his entire record. Prospective students may write directly to the head of any department concerning graduate work in that specific field.

Students from other countries are encouraged to write to the Director of International Student Affairs for information concerning financial matters, housing, and other nonacademic problems.

For unqualified admission to the Graduate School an applicant must have received a baccalaureate degree from an accredited institution, earned under residence and credit conditions substantially equivalent to those required by The Pennsylvania State University. He must have maintained during his junior and senior years a minimum grade point average equivalent to 2.5 on The Pennsylvania State University grading scale (equivalent to half B and half C if all courses carry the same number of credits). Finally, he must ordinarily have completed in a satisfactory manner a certain minimum of course work in designated areas, the specific courses and amount of required work depending upon the field of advanced study which the student proposes to enter. The minimum grade point average of 2.5 during the last two undergraduate years is a general requirement of the Graduate School. Individual departments may require a higher average for admission in their fields.

Conditional admission may be granted to an applicant whose undergraduate grade point average is below 2.5 but whose qualifications in other respects seem to suggest probable success in the Graduate School, provided the applicant's admission is recommended by a major department.\* Such an applicant must realize that the initiative rests entirely with him in communicating with the department of his chosen major and that, if admitted conditionally, he does graduate work at his own risk. There is no assurance that he will subsequently be granted unqualified admission or that the credits earned will automatically be applied toward degree requirements.

Provisional admission may be granted to an applicant whose complete credentials are not available at the time of registration, but this admission will be subject to cancellation if the credentials, on their arrival, do not meet the requirements for admission to the Graduate School. Also, while the applicant is holding provisional admission, certification of any scheduled credits will be withheld until receipt of his official credentials makes possible his permanent admission to the Graduate School. If the provisional admission should, for any reason, be canceled, the student is thereby automatically dropped from the Graduate School and as a consequence will be required to cease attending any 500 level courses for

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\* Some departments do not permit conditional admission.



which he may have registered. He may continue to attend 400 level courses provided he applies for and is accepted for registration as a special student.

A student with a slight deficiency in undergraduate preparation may be admitted and allowed to take a limited number of undergraduate courses to make up the deficiency while proceeding with his graduate program. Courses taken for this purpose do not, of course, apply toward the requirements for an advanced degree.

Formal readmission is not required year by year nor after one or more semesters of absence from the campus unless the student has completed more than 12 credits of work at another institution in the meantime. In this case readmission is required, and evidence of good standing at the institution involved is essential. A student who has earned a master's degree at The Pennsylvania State University should not register for further degree work until his academic record and personal qualifications have been reviewed critically by the department of his major interest and a candidacy evaluation has been completed.

The President of the University, on recommendation of the Dean of the Graduate School, will welcome doctors of philosophy of The Pennsylvania State University, as well as those of other accredited colleges and universities, as guests of the University, with the privilege of attending seminars and courses and of carrying on research. There will be no charge except for laboratory expenses. Arrangements should be made in advance with the Dean of the Graduate School.

A senior student of The Pennsylvania State University lacking not more than 4 credits for graduation may be admitted to the Graduate School. This limit may be increased to 8 credits in the case of a student with an average of at least B (a grade point average of 3). Other senior students, although not admitted to the Graduate School, may, if their records are superior, schedule graduate courses (500 series) upon the approval of the instructor of the course to which the student desires admission, and of the Dean of the Graduate School. Those not admitted to the Graduate School cannot use these credits toward an advanced degree.

**CLASSIFICATION**—At the time of admission to the University, students are classified as graduate, special, or undergraduate students, depending upon their objectives and qualifications.

Upon admission all graduate students are classified either as regular graduate students or as general graduate students. The essential difference between the two groups is that a regular graduate student is working toward an advanced degree at The Pennsylvania State University while a general graduate student is not. Regardless of classification, all students, upon admission to the Graduate School, must register through the Graduate Dean's office for all work taken, whether or not that work is to be credited toward the requirements for a degree.

A special student is not a graduate student, inasmuch as he has not been admitted to the Graduate School, and may not register for graduate courses or research (500 and 600 series) without permission of the Dean of the Graduate School. A special student may register for 400 level courses, provided he has attained at least junior standing in college. Except for most unusual reasons, a special student who is later admitted to the Graduate School may not then count toward degree requirements any credit he has earned while in the special student status.

A person holding a baccalaureate degree and working only for permanent certification as a teacher or administrator in the public schools is advised to apply for admission as a general graduate student.



## REGISTRATION

Changes in classification are arranged through the Graduate School office and, in the case of a change from general to regular status, the approval of the head of the major department in which the student proposes to work is required.

Regular graduate students include those persons who plan to become candidates for degrees at The Pennsylvania State University and who have been formally admitted for advanced study in a particular field. The program of study is developed under the guidance of a department head or his representative. A graduate student who plans to become a candidate for an advanced degree should enroll as a regular graduate student.

It should be emphasized that a student is not a "regular graduate student" unless he has been officially admitted to that status. Regular attendance in the Graduate School, or personal plans for future degree candidacy, do not in themselves carry with them the status or privileges of a regular graduate student.

A regular graduate student who has passed a candidacy evaluation is classified as a doctoral candidate.

An applicant who meets all requirements for admission to the Graduate School, but who does not wish to work for an advanced degree at this institution, may arrange for a program of work as a general graduate student. This classification includes those who plan to transfer credits to another institution and those who plan a special program of study not leading to an advanced degree.

The adviser for a general graduate student is appointed by the Dean of the Graduate School. The student's status and standing will be reviewed by the Dean at each registration. He may not remain a general graduate student longer than one semester (or summer sessions totaling 12 weeks) except with the permission of the Dean, and for definite and good reasons.

When a general graduate student wishes to become a regular graduate student — i.e., to work for an advanced degree at this institution — he should make application to the Dean of the Graduate School for change of status. His undergraduate record will then be re-evaluated to determine whether or not he is prepared to undertake graduate work for a degree in the major field of his choice. He should understand that he may thereafter apply toward degree requirements only those credits earned as a general graduate student which fit definitely and logically into an integrated degree program. There is no upper limit to the number of credits that may be so applied; neither is there a guarantee that any such credits may be applicable.

**REGISTRATION**—The responsibility for being properly registered rests with the student. At least until he has met the minimum requirements for his degree, a student must register for each semester and each summer session in which he proposes to do course work or research, or other work on his thesis, either on or off campus.

For each registration the student, in consultation with his adviser, prepares a schedule of courses and research designed to fit his individual needs, which is then submitted to the Dean of the Graduate School for his approval. The registration process is then completed in the manner specified for all students at the University.

Under certain conditions credit may be earned by work done off the campus. A student contemplating such work should inquire of the Dean of the Graduate School about the procedures and conditions. Such work must be scheduled *in advance* in the regular manner.

A resident student is required to register in person, not by proxy. A nonresident student is expected to assume responsibility for initiating the registration process,

but the details can be handled by mail. A student must register for courses audited as well as for those taken for credit.

Registration dates are given in the University Calendar and a fee is assessed for the privilege of late registration. In any case, registration must be completed within the first two weeks of a semester or within the first one-sixth of any summer session. All changes of schedule must also be completed within this period, except that a student may drop a course at any time within the first four weeks of a semester. A student who is granted permission to register after the beginning of classes will, in general, be required to take a reduced load.

A candidate who has not passed his final examination, but who has met all requirements for his degree including the writing of the thesis, need not register for the semester or session in which the degree is to be conferred.

**ACADEMIC LOAD**—A full-time student is one who devotes "all" his time to studies and/or research, and very little, if any, time to work for financial compensation. The normal credit load is 15 credits per semester, or 1 credit per week in shorter terms such as summer sessions. Larger loads may be scheduled very rarely and only with the approval of the Dean of the Graduate School. Ordinarily a student employed for more than a few hours per week may not register for 15 credits per semester, or 1 credit per week. A student usually is required to count the courses audited as a part of his graduate load. See the *Manual for Graduate Students* for regulations on auditing and visiting classes.

The University takes the position that the facilities of the Graduate School should be made available only to the student who can profit from his graduate school experience to a maximum extent. Therefore the Graduate School reserves the right to deny admission or registration to part-time students who (a) propose schedules of few credits which seem to reflect little real interest in graduate work or would not seem to require serious effort, or (b) wish to carry overloads of such proportions as to handicap them seriously in achieving maximum quality in their graduate work.

A part-time student who is a graduate assistant or an employee of the University is governed by the following load schedules:

EMPLOYMENT OR SERVICE LOAD		CREDIT LOAD ALLOWED	
<i>Hours per Week</i>	<i>Fraction of Full Time</i>	<i>Credits</i>	<i>Fraction of Full Load</i>
0	0	15	5/5
10	1/4	11-13	4/5
20	2/4	8-10	3/5
30	3/4	6-8	1/2
40	4/4	6	2/5

The considerations leading to the establishment of this "protective" schedule of permitted loads for assistants and employees apply equally to part-time students employed off-campus.

**STATUS UNDER SELECTIVE SERVICE**—As soon as an applicant has been admitted to the Graduate School, his local board will be informed *provided* the applicant requests it and has given the necessary information. As soon as he receives notification of admission, the applicant should check with the Associate Registrar to see that everything is in order.



## GRADING SYSTEM

A student is certified to be a full-time student insofar as Selective Service is concerned if he schedules at least 12 credits in a semester, if he holds an appointment as a quarter-time or half-time graduate assistant, or if he is serving an internship under approved conditions.

Whenever a student changes his status so as no longer to be considered a full-time student, fails to make satisfactory progress, or makes a drastic change in his declared goal, his local board will be notified.

**GRADING SYSTEM**—A grade is given solely on the basis of the instructor's judgment as to the student's scholarly attainment.

For graduate courses (500 series) and for research or thesis (600 or 610) one of three grades may be given:

H for Honors, indicating definitely superior attainment.

P for Pass, indicating acceptable but not superior attainment.

F for Fail, indicating failure to attain the acceptable minimum standard of work or to spend an adequate amount of time doing the work scheduled.

In addition to the quality grades listed above, two symbols, "deferred" and R, may appear on a student's transcript. If work is incomplete at the end of a session for a reason beyond the student's control, or if very little work remains to be done, the instructor may report "deferred" in place of a grade, which will appear temporarily on the student's record.

In the case of thesis work, either in progress or completed, the instructor may report the symbol R in place of a grade. This symbol indicates that the student has devoted an adequate amount of time to the work scheduled but gives no indication of its quality. An R remains on the student's transcript permanently. If, after having submitted a series of R symbols, the instructor reports a grade of H, P, or F for a specific session, this grade is considered to apply to the preceding series of registrations and to denote the quality of that entire series.

For 400 series courses one of five grades may be given:

Grade	Percentage Equivalent	Grade Point Equivalent
A	90-100	4
B	80- 89	3
C	70- 79	2
D	60- 69	1
F	0- 59	0

Grades below B do not carry graduate credit and are considered failures in the program of a graduate student.

**GRADUATION**—It is the responsibility of the student to fill out a diploma card and pay thesis fees at the beginning of the semester or session when he expects to receive an advanced degree.

Degrees are normally granted at the end of each semester and at the end of the Mid-Session.

All degrees conferred are tentative until final grade reports have been received even though the student's name may have appeared in the commencement program.

Attendance at commencement exercises is an obligation on the part of those receiving advanced degrees. A request to receive the degree *in absentia* may be presented to the Dean of the Graduate School, but only under extraordinary circumstances will it be granted.



## FEES AND LIVING ACCOMMODATIONS

### REGULAR FEES, PAID EACH SEMESTER:

#### *Students registered for 12 or more credits:*

Residents of Pennsylvania . . . . .	\$175.00
Nonresidents of Pennsylvania, on-campus studies . . . . .	375.00
Nonresidents of Pennsylvania, off-campus research (610) . . . . .	175.00

#### *Students registered for fewer than 12 credits:*

Residents of Pennsylvania, per credit . . . . .	15.00
Nonresidents of Pennsylvania, on-campus studies, per credit . . . . .	32.00
Nonresidents of Pennsylvania, off-campus research (610), per credit . . . . .	15.00

#### *Vocational education courses:*

Total charge for vocational education courses, indicated by "v" following the course number . . . . .	20.00
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#### *Graduate assistants, fellows, and scholars:*

Health and welfare charge . . . . .	20.50
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### SPECIAL FEES, PAID AS OCCASION DEMANDS:

#### *Applicable to all students, including graduate assistants, fellows, and scholars:*

Admission to the Graduate School . . . . .	10.00
Privilege of late registration or late payment . . . . .	10.00
Change of schedule, each change . . . . .	2.00
Microfilming of doctoral thesis and publication of abstract . . . . .	35.00
Minimum fee for binding of thesis, per copy . . . . .	3.00
Official transcript of record (with seal), each copy . . . . .	1.00

The University reserves the right to revise fees without further notice.

Fees are the same for audit courses as for those scheduled for credit.

Summer sessions students who register for graduate courses pay the regular fees for the summer sessions.

Any student who does not fulfill payment obligations promptly may be charged \$1 for each day of delinquency up to and including five days, or a maximum of \$10 if the delinquency exceeds five days. A student whose account is delinquent for more than 10 days is subject to suspension from the University.

Whenever it shall appear from any of the information presented as part of the application for admission that the applicant is not domiciled in Pennsylvania, the Dean of Admissions, when admission is granted to that applicant, assumes that the one admitted is a nonresident of Pennsylvania and includes that admission as a part of the established out-of-State quota. If the student who is thus admitted believes that his circumstances do not justify his classification as a nonresident of Pennsylvania, he may petition the Dean of Admissions for reclassification.

When a petition for reclassification is made, the petitioner is required to present proof of a bona fide continuous domicile of the one admitted (or of his parents, if he is a minor) within the Commonwealth for a period of not less than 12 months immediately preceding the date of such petition for reclassification; and, in addition, such other evidence as is pertinent to a complete review of his classification.

When a student changes his domicile while attending the University, such a student is subject to immediate reclassification by the Dean of Admissions.

## STUDENT AIDS

**REFUNDS OF CHARGES FOR FEES**—Charges for fees are refundable in part upon withdrawal from the University provided the student obtains the Official Withdrawal Form at the Office of the Dean and presents it to the office of the Fee Assessor not later than one calendar month after the effective date of withdrawal from classes. Refunds for a semester are made according to the following schedule:

90 per cent refund upon withdrawal before the end of the first week of classes and a decrease of 10 per cent for each consecutive calendar week thereafter up to and including the 9th consecutive week. No amount will be refunded upon withdrawal after the 9th consecutive calendar week of the semester.

**LIVING ACCOMMODATIONS**—Graduate Hall, located on central campus, provides for about 80 single students including both men and women. For detailed information write to Room Assignment Office, 1-A Irvin Hall. Other living accommodations are available including rooms in private homes and lodging houses. Boarding houses, restaurants, and the Hetzel Union Cafeteria on campus, are available for meals. The cost varies considerably depending upon the type of accommodation. A list of known vacancies is maintained by the offices of the Dean of Men and the Dean of Women and by the Graduate Student Association. The prospective student should write to the appropriate office well in advance of the beginning of classes because it may be very difficult to find a convenient location at the last minute.

A married student may find accommodations in apartments, trailers, and rooms in private homes. Personal contact is essential, but assistance may be gained through the office of the Dean of Men or an advertisement in the local newspaper.

A limited number of married students may be admitted to Eastview Terrace, a housing development consisting of small one- and two-bedroom unfurnished units located on the campus. For details write to 1-A Irvin Hall.

## STUDENT AIDS AND SERVICES

**ASSISTANTSHIPS**—A number of graduate assistantships are available to students who show promise of superior ability to carry on graduate study. An appointee may serve as an assistant in classroom or laboratory instruction, or in research or office work. Exemption from all major fees and charges is granted, but the student must pay the health and welfare charge as well as such specific fees as admission, late registration, and change of schedule. Privileges for a graduate assistant appointed for the academic year do not extend into any of the summer sessions. A veteran holding a quarter-time or a half-time assistantship is eligible for full benefits from the Veterans Administration under Public Law 550.

An appointee may not accept additional employment, either at the University or elsewhere, during the period for which service to the University is required under the appointment. Vacation for a graduate assistant consists of the regular student vacations available to graduate students.

A student holding a quarter-time or a half-time assistantship is considered to be following a full-time course of instruction under Selective Service regulations and is so certified to his local draft board. A student holding a three-quarter-time assistantship is not considered to be following a full-time course of instruction.



A prospective student should write directly to the head of his major department for information and application forms. Appointments are made upon the recommendation of the department head, subject to admission to the Graduate School and to the approval of the Dean of the Graduate School. Clear evidence of superior ability and promise is required. Reappointment to an assistantship requires a continuing demonstration of good scholarship.

The three types of graduate assistantships vary in stipend, service required, and the number of credits for which the student may register. Not all types will be available in every department.

**QUARTER-TIME**, requiring about 10 hours of service per week.

For the academic year: stipend \$603-\$1008; 11-13 credits per semester.

For the fiscal year: stipend \$804-\$1344; 11-13 credits per semester, 8-9 credits in summer sessions.

**HALF-TIME**, requiring about 20 hours of service per week.

For the academic year: stipend \$1206-\$2016; 8-10 credits per semester.

For the fiscal year: stipend \$1608-\$2688; 8-10 credits per semester, 6-8 credits in summer sessions.

**THREE-QUARTER-TIME**, requiring about 30 hours of service per week.

For the academic year: stipend \$1809-\$3024; 6-8 credits per semester.

For the fiscal year: stipend \$2412-\$4032; 6-8 credits per semester, 4-6 credits in summer sessions.

**COUNSELORSHIPS**—A number of appointments are available to male students to serve as resident counselors in the undergraduate residence halls for men. A counselor's responsibility is to work for the social, academic, and emotional adjustment of the undergraduate residents. Specialized training in personnel work is desirable, though not essential.

These appointments are for the academic year and carry with them remission of fees for room and board, but not exemption from academic fees, except that all counselors pay the same fees as would residents of Pennsylvania.

Applications and requests for information should be addressed to the Dean of Men.

**FELLOWSHIPS**—Approximately 90 fellowships are awarded annually. Recipients must be superior students and are frequently required to have completed a certain minimum of graduate work before being eligible for an award. Fellows carry a full-time graduate program, receive a stipend which varies with the award, and have their fees paid by the grantor of the fellowship, or are exempted from the payment of all major fees by the University, as the case may be. They may not accept employment during the term of their appointment, nor are they required to render any service to the University. In some cases a fellow will be expected to limit his research to a broad field specified by the donor of the fellowship. Fellows are required to pay the health and welfare charge and other specific fees such as admission, late registration, and change of schedule.

Eleven fellowships, each providing a stipend of \$2000 and exemption from all major fees for the academic year, are designated as Graduate School Fellowships. They are available to outstanding advanced graduate students in any field, although preference is given to applicants majoring in the humanities and social sciences. Information and application forms may be secured from the Dean of the Graduate School.



## FELLOWSHIPS

Approximately 80 fellowships, with various stipends, are awarded through the individual departments. Information and application forms may be secured from the head of the major department concerned. The fellowships which are awarded will vary somewhat from year to year, but the following are typical of those which were available for 1958-59:

ALLEGHENY LUDLUM FELLOWSHIP—Open to graduate students in metallurgy for studies in steelmaking.

ALLIED CHEMICAL AND DYE CORPORATION FELLOWSHIP IN CHEMICAL ENGINEERING—Available to a graduate student in chemical engineering.

ALLIED CHEMICAL CORPORATION FELLOWSHIP—Open to graduate students in organic chemistry for the final year of study leading to the Ph.D. degree.

AMERICAN IRON AND STEEL INSTITUTE (2) — Open to graduate students in metallurgy.

AMERICAN PETROLEUM INSTITUTE (4) — Open to predoctoral and postdoctoral students in geochemistry, ceramic technology, or allied fields, for fundamental research concerning the synthesis and properties of clays and related inorganic phases.

AMERICAN PETROLEUM INSTITUTE FELLOWSHIPS—Open to graduate students in chemistry and physics for research concerning the synthesis and properties of high molecular weight hydrocarbons.

BASIC, INC. FELLOWSHIP—Open to graduate students in ceramic technology.

CARNEGIE GRADUATE FELLOWSHIPS (3) —Open to advanced level graduate students.

CONTINENTAL OIL COMPANY FELLOWSHIP—Available to graduate students in petroleum and natural gas engineering for studies in petroleum engineering.

CO-OPERATIVE GRANGE LEAGUE FEDERATION FELLOWSHIPS (2) —For research in poultry nutrition and in egg quality, with major interest in biochemistry.

CO-OPERATIVE PROGRAM FELLOWSHIP—Open to graduate students in metallurgy.

CORNING GLASS WORKS FOUNDATION FELLOWSHIP—In support of graduate work on glass or any of its components.

CURTISS-WRIGHT CORPORATION FELLOWSHIP—Open to graduate students in aeronautical engineering, electrical engineering, mechanical engineering, and engineering mechanics.

DANFORTH FOUNDATION FELLOWSHIPS—For graduate students in the natural sciences, the social sciences, the humanities, and other fields of specialization, who are preparing themselves for college teaching and who see in teaching a vocation of Christian service.

DAVISON CHEMICAL COMPANY FELLOWSHIP—Open to graduate students in mineral preparation engineering.

DEVEREUX FELLOWSHIP—Open to selected graduate students in clinical and school psychology.

DOW CORNING FELLOWSHIPS—Open to graduate students in chemistry for fundamental studies in organosilicon compounds.

DU PONT POSTGRADUATE FELLOWSHIP—Open to graduate students in mechanical engineering and engineering mechanics.

EASTMAN KODAK FELLOWSHIP IN CHEMISTRY—Open to advanced graduate students in chemistry for study leading to the Ph.D. degree.

ELLIOTT FELLOWSHIP IN ENGINEERING RESEARCH—An annuity provided by W. S. Elliott of Pittsburgh for a graduate student in engineering.

ESSO RESEARCH AND ENGINEERING POSTGRADUATE FELLOWSHIP IN CHEMISTRY—Open to advanced graduate students in the Department of Chemistry for one year of study leading to the Ph.D. degree.

GENERAL ELECTRIC FELLOWSHIP—Open to graduate students in metallurgy.

**GENERAL FOODS FUND FELLOWSHIPS**—Two fellowships at \$3000 each for full-time study toward a master's or a doctor's degree in any major in home economics.

**GULF OIL COMPANY FELLOWSHIP IN PETROLEUM AND NATURAL GAS ENGINEERING**—In support of graduate work in petroleum and natural gas engineering for studies in petroleum production.

**HALOID XEROX FELLOWSHIP IN PHYSICS**—In support of graduate work in the field of solid state physics.

**HAMILTON STANDARD FELLOWSHIPS (2)**—Open to graduates of this University in aeronautical engineering, electrical engineering, mechanical engineering, and engineering mechanics.

**IMPERIAL OIL, LTD.**—Granted for study of cretaceous sediments in Alberta, Canada. On personal basis only, to student majoring in mineralogy.

**JONES & LAUGHLIN FELLOWSHIP**—Open to graduate students in ceramic technology for studies in refractories.

**KAISER ALUMINUM & CHEMICAL CORPORATION**—Open to students in ceramic technology for studies in ceramic technology.

**KENNECOTT COPPER CORPORATION FELLOWSHIP**—Open to graduate students in geophysics for studies relating to mining geophysics.

**LEAD INDUSTRIES FELLOWSHIP**—Open to graduate students in ceramic technology for studies of lead oxide systems.

**LITHIUM CORPORATION OF AMERICA FELLOWSHIP**—Open to graduate students in ceramic technology for studies in inorganic lithium compounds and lithium oxide systems.

**MOLYBDENUM CORPORATION OF AMERICA FELLOWSHIP**—For graduate students in mineral preparation engineering.

**MONSANTO CHEMICAL COMPANY SUMMER FELLOWSHIP IN CHEMISTRY**—Open to a graduate teaching assistant in chemistry for support of study during the summer terms.

**NEW YORK LIFE INSURANCE COMPANY FELLOWSHIP**—Open to graduate students in insurance.

**EDWARD ORTON, JR., CERAMIC FOUNDATION FELLOWSHIP**—Open to graduate students in ceramic technology for studies relating to kiln-fired ceramic bodies.

**PAN-AMERICAN FELLOWSHIP IN PETROLEUM AND NATURAL GAS ENGINEERING**—Open to graduate students in petroleum and natural gas engineering for studies in petroleum production.

**PENNSYLVANIA NATURAL GAS MEN'S FELLOWSHIP**—Available to graduate students in petroleum and natural gas engineering for studies in gas technology.

**PITTSBURGH PLATE GLASS FELLOWSHIP**—Open to graduate students in ceramic technology for fundamental studies of glass.

**ROCHESTER AND PITTSBURGH COAL FELLOWSHIP**—Open to graduate students in mining engineering.

**SHELL FELLOWSHIP IN CHEMICAL ENGINEERING**—In support of graduate work in chemical engineering, preferably for a student in the last year of his doctoral work.

**SHELL FELLOWSHIP IN CHEMISTRY**—Open to graduate students in the Department of Chemistry for the final year of study leading to the Ph.D degree.

**SPEER CARBON FELLOWSHIP**—Open to graduate students in fuel technology for studies on carbon.

**SPRAGUE ELECTRIC COMPANY FELLOWSHIP**—Open to graduate students in ceramic technology for studies in the field of ceramic dielectrics.

**STACKPOLE FELLOWSHIP IN METALLURGY**—Open to graduate students in metallurgy for studies in powder metallurgy.



## SCHOLARSHIPS

**STACKPOLE CARBON FELLOWSHIP**—Open to graduate students in ceramic technology for studies in the field of ceramic ferrite materials.

**L. L. STEARNS AND SONS FELLOWSHIP**—Open to graduate students in retailing.

**SUN OIL COMPANY FELLOWSHIP IN CHEMISTRY**—Open to advanced graduate students in chemistry for study leading to the Ph.D degree.

**UNION CARBIDE CORPORATION FELLOWSHIP IN CHEMISTRY**—Open to graduate students in chemistry for the final year of study leading to the Ph.D degree.

**UNION CARBIDE AND CARBON FELLOWSHIPS (2)**—Open to graduate students in metallurgy.

**UNITED STATES DEPARTMENT OF HEALTH, EDUCATION AND WELFARE TRAINEESHIPS IN VOCATIONAL REHABILITATION COUNSELING**—Open to graduate students in the Department of Education specializing in rehabilitation counseling.

**UNITED STATES PUBLIC HEALTH SERVICE FELLOWSHIPS (TRAINEES)**—Open to selected graduate students in clinical psychology.

**UNITED STATES STEEL FOUNDATION FELLOWSHIP**—Open to graduate students in the College of Mineral Industries for studies related to steel-making.

**VETERANS ADMINISTRATION INTERNSHIPS**—Open to students in clinical or counseling psychology.

**YOUNGSTOWN SHEET AND TUBE COMPANY FELLOWSHIPS**—Open to graduate students in mining engineering.

In addition, numerous grants are available from governmental agencies, industrial concerns, and foundations for the support of investigations of particular problems. Many of these permit full-time study and carry the same fee exemptions as the fellowships listed above. Detailed information may be secured from departments.

Among these are the National Science Foundation Predoctoral Fellowships for graduate study in physical sciences, mathematics, biological sciences, earth sciences, psychology, anthropology, and areas where natural sciences converge with social sciences. These fellowships are used at the university of one's choice, and application should be made to the National Science Foundation, Washington 25, D. C.

**DU PONT POSTGRADUATE TEACHING ASSISTANTSHIP IN CHEMISTRY**—Open to a graduate student in chemistry who has had two years' experience as a graduate teaching assistant.

**JOHN W. WHITE FELLOWSHIPS**—Awarded to two graduates of The Pennsylvania State University each year on the basis of scholarship, need, character, and attitude. The recipients may enroll in any approved college or university.

**SCHOLARSHIPS**—A number of scholarships are awarded annually by the Graduate School, by individual departments, and by outside agencies and organizations.

**GRADUATE SCHOLARSHIPS**—Forty are awarded each year. These scholarships carry no stipend but do grant exemption from all major fees. Recipients are required to take a full program of graduate work and may not accept employment for remuneration. They may be called upon by their major department for a limited amount of service without compensation.

Applications should be addressed to the Dean of the Graduate School and must be received by March 1 in order to be considered for the following academic year.

**A.A.U.W. SCHOLARSHIP**—The State College Branch of the American Association of University Women has established a scholarship for a woman graduate student. The amount of the award varies and does not include fee exemption.

**LOAN FUNDS**—Funds are available for limited loans. Applications should be addressed to the Dean of Men or the Dean of Women.



**STUDENT EMPLOYMENT**—Many students depend partly on their own earnings to help meet their expenses. The Student Employment Office, 112 Old Main, gives information on part-time jobs. A student not holding an assistantship, fellowship, or scholarship who wants a part-time job should register with the Student Employment Office as soon as his class schedule has been arranged. While some students find regular part-time work, many of them depend on a series of odd jobs.

**VETERANS BENEFITS**—The Co-ordinator of Veterans Affairs has the responsibility of handling all applications for benefits under the various Public Laws.

Under P.L. 550 the responsibility for classifying students as to their rate of training rests with the Dean of the Graduate School. The classification is based on the extent to which the student devotes himself to his graduate program (as contrasted with the service for which he receives remuneration) and is not directly determined by the number of credits scheduled. Thus a student who is employed about 20 hours per week and devotes the remainder of his time to graduate work would be considered a half-time student on the basis of his employment regardless of how many credits he was permitted to schedule and regardless of his position, unless he be a graduate assistant. A quarter-time or a half-time graduate assistant is considered to be a full-time student and a three-quarter-time graduate assistant is considered to be a half-time student insofar as benefits under P.L. 550 are concerned.

**HEALTH CENTER**—Graduate assistants, fellows, holders of graduate scholarships, and students who schedule 12 or more credits are entitled to 7 days of free treatment in the University Hospital by the University Health Center staff each semester. A nominal charge of \$3 is made for each day of hospitalization in excess of 7 days in any given semester. Almost all modern drugs are furnished free of charge as required for treatment, but the student may be charged extra for medication where such treatment is unusual or extremely expensive. Consult the *Manual for Graduate Students* for details concerning facilities and services.

**INSURANCE PLAN**—A voluntary Accident and Sickness Insurance Plan with a variety of benefits is available to graduate students and their families. The Student Government Association, which operates the Plan, has offices in the Hetzel Union Building.

**PLACEMENT SERVICE**—The University Placement Service is designed to co-ordinate the placement activities of all the Colleges and the Graduate School. It is available to any student who is in need of counseling or guidance on employment problems. The services of the following divisions are available to the student without charge.

The Placement Service functions primarily as a clearing house, bringing together students, alumni, faculty members, and representatives of organizations that are seeking college-trained personnel. Summer jobs other than those at camps or resorts are listed at this office.

The Teacher Placement Division assists seniors, alumni, and graduate students in all departments in securing teaching positions for which they are qualified.

The Student Employment Division offers assistance to students in finding part-time employment in town and on the campus, as well as summer employment at camps and resorts. A student must be registered to be informed of jobs.

**RELIGIOUS PROGRAMS**—The University seeks to serve the spiritual needs of its students and staff. General responsibility for religious activity on the campus

## MASTERS' DEGREES

rests with the University Chaplain and Co-ordinator of Religious Affairs. Individual organizations under the sponsorship of members of the Jewish, Protestant, and Roman Catholic faiths serve the student body. Many other religious organizations, including denominational and interdenominational groups, are active on the campus and in association with local churches.

**STUDENT AFFAIRS**—The Graduate Student Association is the official University-wide organization of graduate students. All students enrolled during the academic year have membership in the Association, which promotes the general welfare and the academic interests of graduate students. It publishes the *Graduate School Newsletter*, maintains an up-to-date list of housing for graduate students, helps to sponsor the Graduate School lecture series, and sponsors social functions.

**SUMMER SESSIONS**—A series of sessions covering a total period of 12 weeks are arranged each summer. During this time there are excellent opportunities for graduate work in many fields. Detailed information can be secured from the *Summer Sessions Complete Announcement*, which is published about April 1 and may be obtained by writing to the Dean of Summer Sessions.

It is the aim of the University to make available its staff and resources during the summer to aid students to the fullest possible extent in their programs of graduate study and research. The University cannot guarantee, however, that all the services normally offered during the academic year will be available during the summer.

To avoid disappointments, a student who plans to present a thesis for final consideration or to take the final doctoral examination during the summer sessions should inform the chairman of his committee and the head of his department of his intentions prior to June 1. A notice of approval will be sent to the student if the necessary staff members will be available to provide the service requested.

A graduate student desiring to carry forward a special graduate program or research project not officially listed as a part of the summer sessions should, likewise, obtain written approval of his plans from the chairman of his committee and the head of his department prior to June 1.

## MASTERS' DEGREES

The Graduate School recognizes a difference in purpose, which is reflected in the requirements, for two types of advanced degrees: academic and professional. Of the seven masters' degrees conferred, the Master of Arts and the Master of Science are academic in nature. The professional degrees conferred are Master of Agriculture, Master of Education, Master of Engineering, Master of Forestry, and Master of Public Administration.

**ADMISSION**—Adequate undergraduate preparation is required in the field in which the applicant expects to pursue advanced work. The specific courses and the total number of undergraduate credits required in various areas will be determined by the choice of field and can be ascertained from the Dean of the Graduate School. An applicant who meets the minimum grade point average but is deficient in course preparation may, under certain circumstances, be admitted to the Graduate School and allowed to make up the undergraduate deficiencies. Under these circumstances the program will require more than the minimum period of residence. An applicant for admission to the M.Ed. program is required to have had at least 27 credits in the field of education, including practice teaching.



**GENERAL REQUIREMENTS**—A program for the master's degree requires a minimum of 30 credits which may be earned as a full-time or as a part-time student and by attendance either during the academic year or during the summer. All requirements, whether satisfied here or elsewhere, must be met within six years, or a period spanning seven consecutive summers.

A candidate for the master's degree may apply toward the minimum requirements a total of 10 credits of approved off-campus work. This includes work transferred from other institutions, Penn State extension courses, off-campus research or projects, and courses in which the student does his work while away from the campus. This rule is modified somewhat for students following the cooperative program in Public Health Nutrition and for candidates for the degree of Master of Engineering.

A candidate for a master's degree should understand that a well-balanced, unified, and complete program of study will be required regardless of the minimum credit requirement. A degree is not conferred for a mere collection of credits. Many students find it necessary to earn more than the minimum number of credits before they are regarded as being ready for the degree. In order to avoid possible disappointment the student should not think of the master's degree as a "one-year degree." The University is not committed to granting a degree upon completion of 30 credits.

After a student has been admitted as a regular graduate student, he should confer with the head of his major department concerning the appointment of an adviser. The general guidance of a master's candidate is the responsibility of an adviser, or of a committee appointed in a manner to be determined by the major department in which the student is specializing. The adviser or the committee assists the student in planning a program of study. Although the adviser is frequently the supervisor of the thesis, this is not necessarily the case.

Requirements concerning courses, language proficiency, minors, comprehensive examinations, and other matters are sometimes made by departments in addition to (but not in conflict with) the regulations of the Graduate School. For details the student should consult the head of the major department.

## M.A. AND M.S.—ADDITIONAL SPECIFIC REQUIREMENTS

The Master of Arts and the Master of Science degrees have similar requirements, the particular degree conferred upon the student being determined by the general area in which he majors.

In fulfillment of degree requirements a candidate must present a major and either a minor field of study or an approved group of general studies. A minor consists of no fewer than 6 credits of integrated or articulated work in one field related to but different from that of the major. A general studies group consists of no fewer than 6 credits in a field other than that designated as the major field and considered by the major department to have significance and value for the candidate.

At least 18 credits in graduate courses (500 series) and thesis research (600 or 610) combined must be included in the program. A minimum of 12 credits in course work, as contrasted with research, must be completed in the major field and at least 6 credits must be devoted to a thesis.



## MASTERS' DEGREES

The thesis is prepared under the direction of the department in which the candidate's major work is taken. Under certain conditions a student may be permitted to complete the thesis off-campus. To obtain such permission he must make satisfactory arrangements in advance with both the major department and the Dean.

A *Thesis Information Bulletin*, which gives details concerning format, paper, illustrations, and other items, may be obtained at the Graduate School office.

### M.AGR.—ADDITIONAL SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Agriculture has a professional orientation and provides training for increased professional competence in the various fields of agriculture. It should be clearly distinguished from the research-oriented program which leads to the academic degree of Master of Science.

A candidate is required to earn at least 12 credits in graduate courses (500 level) and a minimum of 12 credits outside his major field.

In addition to credit requirements, a candidate is required to present a paper on a selected professional problem comparable in quality to a thesis. This paper is to be an exercise in applying scientific methods to the solution of a problem. Skills must be demonstrated in ability to (a) formulate and state meaningfully the problem and objectives, (b) critically analyze the present state of knowledge concerning the problem, (c) acquire and analyze information to help answer the problem, (d) draw logical conclusions, and (e) interpret the relationship between findings and professional problems. The paper will be evaluated by a committee appointed by the Dean of the Graduate School.

The candidate is required to pass a final examination to be administered by a committee of three faculty members appointed by the Dean of the Graduate School with at least one member from a department other than the one sponsoring the major field in which the candidate is working.

### M.ED.—ADDITIONAL SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Education provides preparation for increased professional competence in the several fields of education. It should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Arts or Master of Science.

A minimum of 24 credits must be earned in course work. The larger part of this shall be in 500 series courses. The needs of the student shall be considered in arranging the best combination of 400 and 500 series courses for the preparation of the candidate in his particular field.

When the candidate chooses a group major, his program of study will be approved by a standing committee which will serve in the same relation to him as does a department in the case of a student with a specific major.

**MAJOR AND MINOR FIELDS**—A student may major in one of the fields of education, such as elementary education, art education, or home economics educa-

tion, with a minor in an area outside the fields of education. In this case the program is under the guidance of the appropriate department of education.

However, a student who is preparing to teach in a specific subject-matter area such as English, mathematics, or history may choose such a field as his major and take the majority of his work in it under the guidance of that department. In this case the student is required to have a minor consisting of no fewer than 6 credits in education. All candidates are required to take the examination in basic education which is administered by the Department of Education. If adequate background is demonstrated, the candidate may then minor in any field of education. If adequate background is not demonstrated, the minor must be in basic education, which includes specific courses in comparative education, educational measurements and statistics, educational psychology, history of education, and philosophy of education.

A student wishing to work in a broader field may choose a group major, such as social studies, physical science, or biological science. In this case, at least 24 credits are to be devoted to the group, and at least 6 to a minor in education. It is expected that each student will choose one subject of the group as a field of primary interest, to which at least 12 credits are to be devoted. All candidates are required to take the examination in basic education which is administered by the Department of Education. If adequate background is demonstrated, the candidate may minor in any field of education; if not, the minor is restricted to basic education.

A student who is majoring in educational administration or in counseling in education may minor in either basic education or in a field outside of education. A minimum of 6 credits is required.

A candidate majoring in one of the fields of education is required to take a departmental diagnostic examination which serves as a guide in outlining a program of study that will fit his individual needs.

**THESIS OR TERM PAPER**—Six credits may be granted for an approved thesis. Those candidates who do not elect to write a thesis are required to present an essay or term paper. It must be of considerable proportion, giving evidence of their capacity to describe a serious intellectual experience adequately in writing, and giving unmistakable evidence of ability to formulate and state meaningfully the purpose of an investigation, study, critical analysis, or evaluation; to acquire and analyze information; to draw conclusions logically; and to relate findings to professional problems and practices. The particular nature and extent of such a piece of writing, whether it be required in connection with a course or independently of course work, and when it is to be undertaken shall be determined by the major department. The department shall report to the Dean of the Graduate School the title, the name of the faculty member under whom the student did the work, and whether the work was considered adequate. It is the right, but not the responsibility, of the department to require one or more copies of such an essay for its library or other files.

Candidates for the Master of Education degree must pass a final comprehensive examination. The examination will be designed to determine the ability of the candidate to apply the general as well as the special knowledge of his chosen field to practical situations.



## MASTERS' DEGREES

### M.ENG.—ADDITIONAL SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Engineering provides training for advanced professional competence in the several fields of engineering. It should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Science.

At least 12 credits must be earned in graduate courses (500 series), and a minimum of 6 credits must be earned outside the candidate's field of concentration.

A scholarly written report on a developmental study involving at least one area represented in the candidate's course work is required as an integral part of the program. The report must be comparable in its level of work and quality to a graduate thesis.

No work for this degree is required to be done in residence provided the major department or supervisory committee agrees that a suitable program can be pursued off-campus.

### M.F.—ADDITIONAL SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Forestry provides training for increased professional competence in the several specialized areas of forestry and wood utilization. It should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Science with a major in forestry.

A candidate for the degree of Master of Forestry should choose one field of work for his major and one or two related fields for his minor. The proportion of credits to be taken in the major and minor fields of study will be determined in consultation with the student's advisory committee. It is expected that the larger part of the program shall be in graduate courses (500 series), but no specific number of credits in the 500 series is required.

Each candidate is required to prepare and submit an acceptable thesis. At least 6 credits of thesis work is required.

### M.P.A.—ADDITIONAL SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Public Administration provides pre-service training for students planning to enter the field of public administration at the national, state, or local level.

The program covers a 12-month period and consists of two semesters of work on campus, followed by an internship of six weeks in some governmental agency. The course of study is made up of subject blocks, such as organization, management, personnel administration, budgeting, finance, accounting, public works administration, administrative law, planning, statistics, report writing, speech, and public relations. The student has a major in public administration and a minor in either public finance or public works, depending upon his interest.

In lieu of a thesis, the student is required to submit an extensive written report on a project which has been carried out during his internship.

This degree is a terminal one and cannot be applied toward a doctorate.



## DOCTORAL DEGREES

The Doctor of Philosophy, an academic degree, and the Doctor of Education, a professional degree, are conferred. The two programs are recognized as different in purpose and consequently have different requirements in certain respects.

**ADMISSION**—A student who meets the general requirements for admission to the Graduate School and has been accepted by the department or committee in charge of a major field in which the doctorate is offered, may begin working toward that degree. However, he has no official status as a doctoral student and has no assurance that he will be accepted as a doctoral candidate until he has passed a candidacy examination. This examination is administered by the major department and is given near the end of the first, or at the beginning of the second, year of graduate work including that done for the master's degree and work done elsewhere as well as here (i.e., at about the time he has earned a total of 30 graduate credits).

A new student transferring from another graduate school with 30 or more transfer credits must take this examination before he has earned more than 10 credits here.

**GENERAL REQUIREMENTS**—No specified number of courses completed or credits earned will assure the attainment of the doctorate. The general requirements are based upon a period of residence, the passing of comprehensive examinations, and the writing of a satisfactory thesis. A doctoral program consists of such a combination of courses, seminars, and individual study and research as meets the minimum requirements of the Graduate School and is approved by the doctoral committee for each individual student. It includes work in a major field of study and in either a minor field or a group of general studies.

**RESIDENCE REQUIREMENTS**—A minimum of three academic years of full-time graduate study and research, or their equivalent in credits, is required for a doctor's degree.

At least 30 credits must be earned in residence at The Pennsylvania State University. For the Ph.D. degree a candidate must earn the minimum of 30 credits in residence in regular semesters, and for at least two semesters his work load must be limited to half-time at most, the balance of his time being devoted to graduate study. For the D.Ed. degree, the minimum residence requirement may be met by attendance at summer sessions, although there is no guarantee that it will be possible to do so in all cases.

The first year of graduate study leading to the doctor's degree may be substantially the same as that provided for the master's degree, although a master's degree is not a prerequisite for the doctorate.

**OFF-CAMPUS AND TRANSFER CREDITS**—A maximum of two full academic years of residence work in another approved school granting the doctorate in the major field may be accepted by the Graduate School in partial fulfillment of the requirements for a doctoral degree at The Pennsylvania State University. Not more than one year of residence at a graduate school not granting the doctorate in the major field will be accepted here to apply toward doctoral degree requirements. Credit for courses and research work done elsewhere can be used to meet degree requirements, however, only if the work is appropriate to the candidate's proposed program of study as determined by his doctoral committee.

## DOCTORAL DEGREES

By securing the maximum allowable number of transfer credits, it is possible theoretically to complete the requirements at this institution in one academic year. In practice, however, this is rarely possible because of the sequence required in courses and examinations, special departmental requirements, and the possibility of protracted research. It must be remembered that the quality of the program rather than the time requirement is of paramount concern.

Subject to the approval of his adviser, the head of his major department, and the Dean of the Graduate School, a student may register for research to be done off-campus. Such work will not be approved, however, simply because the arrangement is convenient for the student; scholarly considerations must determine the choice of location. A doctoral candidate may register for a maximum of 30 credits of off-campus research, but these credits must be included in the 60 credits (two academic years) which a candidate may earn in off-campus study. The maximum load permitted a student who is employed full time is 6 credits in a semester and 5 credits distributed over the 12 weeks of the summer.

A candidate for a doctor's degree may apply a maximum of 10 credits earned in approved extension classes of The Pennsylvania State University toward the minimum requirements, but not more than three of these credits may have been earned prior to June 9, 1952. Extension credits must be included in the 60 credits which a candidate may earn in off-campus study, comprising transfer credits, off-campus research, and extension credits. No correspondence credits are acceptable.

**ADVISERS AND DOCTORAL COMMITTEES**—After a student has been admitted as a regular graduate student, he should confer with the head of his major department concerning departmental procedures and the appointment of an adviser. The arrangement and approval of the details of the semester-by-semester schedule of the student is the function of the adviser. This person may be a member of the doctoral committee or someone else designated by the head of the major department for this specific duty.

The general guidance of a doctoral candidate is the responsibility of a doctoral committee consisting of five or more members of the Graduate Faculty. The committee is appointed by the Dean of the Graduate School, upon recommendation of the head of the major department, at the time the student is admitted to candidacy. The chairman of the committee must hold full membership in the Graduate Faculty. The supervisor of the candidate's thesis will usually, but not necessarily, be designated as chairman. At his discretion, the Dean may add additional members to the committee.

The doctoral committee is responsible for establishing the broad outline of the student's program and should review the program as soon as possible after admission to candidacy. The committee will prepare, give, and evaluate the candidate's examinations, and supervise and approve his thesis. A favorable vote of at least two-thirds of the members of the committee is required for passing a comprehensive or a final examination. If a candidate fails an examination, it is the responsibility of the doctoral committee to determine whether he may take another examination.

The committee will also notify the Dean when the candidate is ready to have his comprehensive and his final examination scheduled and will report the results of these examinations to the Dean.

**LANGUAGE EXAMINATIONS**—Candidates for the D.Ed. degree are not required to demonstrate a reading knowledge of a foreign language unless a special requirement is set up by the major department.



For the Ph.D. degree, the candidate is required to have a reading knowledge of at least two foreign languages. German and French are the languages most often needed. Other languages may be presented instead of these, if their choice is determined by scholarly and professional reasons. The choice of a language must be approved by the major department. If a language other than English, French, German, Italian, Russian, or Spanish is presented, it must be approved also by the Dean of the Graduate School. A student may not present his "mother tongue" as one of the two languages required in candidacy.

An important value of the foreign language training lies in the need to introduce the student to the non-English literature of a subject, and to make possible the use of this literature both during graduate training and during his subsequent professional career. The candidate for a degree therefore should prepare early in his graduate program to meet the foreign language requirements.

The language examinations are administered by the respective language departments of the University and are held three times each year, once during each semester and once during the Mid-Session. Specific dates may be obtained from the language department or from the calendar in the *Graduate School Announcement*. So as to determine adequacy of preparation for the regular examination, every candidate is required to present himself to the language department concerned for a preliminary test in oral translation, not to exceed 15 minutes duration, either during Orientation Week of the Fall or Spring Semester, or during the first week of the Mid-Session. A candidate is allowed only one such preliminary examination.

Certificates of proficiency must be obtained if language requirements have been met at another institution prior to admission to the Graduate School at Penn State. In this case it is the general policy to require a letter from the Graduate Dean of the institution in which the foreign language examination was taken, stating that the examination taken by the student was that required of prospective Ph.D. candidates. Other evidence, such as examinations here, may also be required. (See the *Manual for Graduate Students* regarding the nature of the examination and registration therefor.)

**COMPREHENSIVE EXAMINATIONS**—A candidate for the Ph.D. or D.Ed. degree is required to take a comprehensive examination covering his major and minor fields to determine whether he had adequate mastery of the subject matter to entitle him to proceed to the completion of a thesis.

This examination will normally be taken when the candidate has substantially completed his course work. In no case may the final examination be scheduled less than three months after the comprehensive examination. The comprehensive examination is to be given and evaluated by the doctoral committee and may be either written or oral, or both. A favorable vote of at least two-thirds of the members of the committee is required for passing. If a candidate fails, it is the responsibility of the doctoral committee to determine whether he may take another examination. The results are reported to the Dean of the Graduate School.

A candidate for the degree of Doctor of Philosophy must have satisfied the language requirements before taking the comprehensive examination.

**FINAL ORAL EXAMINATIONS**—The doctoral candidate who has satisfied all other requirements for the degree will be scheduled, on recommendation of the doctoral committee, to take a final examination. In no case may the final examination be scheduled less than three months after the comprehensive examination. The deadline for holding the examination is three weeks before Commencement.



## DOCTORAL DEGREES

The final examination is oral, open to the public, and related in large part to the thesis; but it may cover the whole field of study of the candidate without regard to courses that have been taken either here or elsewhere.

A favorable vote of at least two-thirds of the members of the committee is required for passing. The results of the examination are reported to the Dean of the Graduate School and will be entered upon the candidate's official record. If a candidate fails, it is the responsibility of the doctoral committee to determine whether he may take another examination.

### PH.D.—ADDITIONAL SPECIFIC REQUIREMENTS

The degree of Doctor of Philosophy is conferred in recognition of high attainment and productive scholarship in some special field of learning as evidenced by (1) the satisfactory completion of a prescribed period of study and investigation, (2) the preparation of a thesis involving independent research, and (3) successfully passing examinations covering both the special subject and the general field of learning of which this subject forms a part.

The program for the Ph.D. includes a major and either a minor or a group of general studies. Approximately two-thirds of the total time is to be devoted to the major field. A minor consists of no fewer than 15 credits, including those applied towards the master's degree, of integrated or articulated work in one field related to, but different from, that of the major. A general studies group consists of no fewer than 15 credits, including those applied toward the master's degree, in fields other than that designated as the major field and considered by the major department to have significance and value for the candidate.

**THESIS**—The ability to do independent research and competence in scholarly exposition must be demonstrated by the preparation of a thesis on some topic related to the major subject. It should represent a significant contribution to knowledge, be presented in a scholarly manner, reveal on the part of the candidate an ability to do independent research of high quality, and indicate considerable experience in using a variety of research techniques. The contents and conclusions of the thesis must be defended at the time of the final examination.

The completed thesis together with an abstract, typewritten in triplicate, must be filed in the office of the Dean of the Graduate School not later than two weeks prior to the commencement at which the candidate expects to receive the degree.

A *Thesis Information Bulletin*, which gives details concerning format, paper, illustrations, and other items, may be obtained at the Graduate School office.

### D.Ed.—ADDITIONAL SPECIFIC REQUIREMENTS

The degree of Doctor of Education is conferred in recognition of advanced preparation of a high order for work in the profession of education as evidenced by (1) the satisfactory completion of a prescribed period of study; (2) ability to apply scientific principles in classroom instruction, supervision of instruction, administration, or as a consulting specialist in certain educational areas; (3) preparation of a thesis demonstrating ability to undertake an educational problem with originality

and independent thought; (4) successfully passing examinations showing a satisfactory grasp of the field of specialization and its relation to allied educational areas; and (5) showing recognized potential for leadership in the profession of education.

Every candidate must show, through comprehensive examinations, that he is familiar with current theories of education; that he understands and can apply the techniques and the findings of educational research so far as they bear upon the teaching of his subject; that he is prepared to read understandingly and contribute to the technical and professional literature in his field; and that he can criticize his own procedures in the light of historical trends and practices in this and other countries. Command of the tools for a thorough study of the problems of education is necessary and must include familiarity with statistical methods. For certain students the requirements may include a reading knowledge of one or more foreign languages.

**MAJOR AND MINOR FIELDS**—The program of study includes a major and either a minor or a group of general studies. A majority of the courses offered in fulfillment of the requirements must be in the major field of study.

A candidate choosing a major outside the fields of education (such as chemistry, English, or history) shall have a minor consisting of not less than 15 credits, including those applied toward the master's degree, in psychology and basic education (includes specific courses in comparative education, educational measurements and statistics, educational psychology, history of education, and philosophy of education).

A candidate choosing a major in one of the fields of education must also choose either a minor or a group of general studies with the approval of the major department. In this case a minor consists of no fewer than 15 credits, including those applied toward the master's degree, in one field outside the fields of education. An acceptable general studies group consists of no fewer than 15 credits, including those applied toward the master's degree, in fields outside the fields of education considered by the major department to have significance and value for the candidate.

**THESIS**—Evidence of a high degree of scholarship, competence in scholarly exposition, and ability to select, organize, and apply knowledge must be presented by the candidate in the form of a written thesis. The candidate must demonstrate a capacity for independent thought as well as ability and originality in the application of educational principles or in the development of new generalizations under scientific controls. The thesis may be based upon a product or project of a professional nature, provided that scholarly research is involved. For example, it may be based upon the solution of a professional problem concerned with the development of a curriculum, or a product of creative effort related to education. However, in order to be acceptable as a thesis, the professional project must be accompanied by a written discourse demonstrating the nature of the research and including such theories, experiments, and other rational processes as were used in effecting the final result. The topic and outline of the proposed thesis must have the approval of the doctoral committee.

The completed thesis together with an abstract, typewritten in triplicate, must be filed in the office of the Dean of the Graduate School not later than two weeks prior to the commencement at which the candidate expects to receive the degree.

A *Thesis Information Bulletin*, which gives details concerning format, paper, illustrations, and other items, may be obtained at the Graduate School office.



## TECHNICAL DEGREES

The degrees conferred are Fuels Engineer, Ceramic Engineer, Engineer of Mines, Metallurgical Engineer, and Petroleum Engineer.

**ADMISSION**—A graduate of the College of Mineral Industries of this University may be admitted to work for a technical degree, provided he submits evidence of having been engaged for a period of not less than three years in acceptable professional work in the field in which the application for the degree is made.

A technical degree may also be granted to an engineer of approved practical experience who is a graduate in engineering of another institution of equal standing, on completion of at least three years of full-time teaching or research work in engineering in a professional rank in this institution, and upon presentation of an acceptable thesis and the fulfillment of all other requirements for technical degrees.

An applicant for a technical degree must file with the Dean of the Graduate School an application filled out in duplicate on the prescribed forms, approved by the head of the department in which the undergraduate work was completed. The application should be accompanied by the admission fee of \$10.

**REQUIREMENTS**—Not less than three years shall have elapsed from the time of receiving the first degree before a graduate of this institution shall be permitted to file his application for a technical degree. The application for a technical degree shall include evidence of a satisfactory professional record, which must be approved by the executive committee of the undergraduate College concerned.

Registration for these degrees is the same as for resident students. A candidate must be registered during two regular semesters.

In order to be recommended for a technical degree, the candidate must prepare a thesis on a subject related to his profession, and he may be required to appear in person to defend his thesis.

**THESIS**—Immediately following registration the candidate must submit for approval an outline of his proposed thesis; and at least six weeks prior to the day on which the degree is to be conferred, the complete thesis must be in the office of the head of the department concerned.



# PROGRAMS AND COURSES

**PROGRAMS** of study leading to advanced degrees are offered in many major and minor fields. These are listed in the following section, and the major fields are summarized on page 52. Related courses are grouped together under the name of the field. To locate a particular field or group of courses consult the index.

In general, departments of the University are identified with specific major fields. Thus aeronautical engineering is a major field of study which is offered under the supervision of the Department of Aeronautical Engineering. On the other hand, biological science and comparative literature are major fields for which there are no corresponding departments. In such cases a committee of the Graduate School is responsible for administering the program. In some cases a single department offers work in more than one field. Thus the Department of Civil Engineering offers work in both civil and sanitary engineering.

Applicants for admission are encouraged to consult the person whose name is listed under the major field heading.

**DEGREES**—In those major fields approved for the doctorate the Ph.D. is normally conferred, although a program leading to the D.Ed. may also be arranged with the consent of the department or committee in charge if such a professional program is appropriate. Similarly in major fields approved for the master's degree the M.A. or M.S. is normally conferred, but a program leading to the M.Agr., M.Ed., or M.Eng. may also be available. The D.Ed. and M.Ed. are not limited to the fields of education, but with the consent of the department or committee in charge may be offered in any approved major field appropriate to the preparation of teachers, such as chemistry or English. In this case the program is sponsored by a major department outside the fields of education, such as the Department of Chemistry, but the student's minor is in education.

**MINOR FIELDS**—All major fields listed are also acceptable as minors. In addition, a few fields in which no advanced degrees are offered have been approved as minors for candidates who are majoring in related areas. Such minor fields are identified by a brief statement under the field heading.

A candidate's choice of minor field depends upon the particular degree he is seeking and is subject to the approval of his major department. The requirements in each minor field are established by the minor department subject to the regulations of the Graduate Faculty.

**INTERDISCIPLINARY MAJORS**—In addition to the majors listed on page 52, interdisciplinary majors involving two or more departments may be arranged with the approval of the Dean of the Graduate School. These programs are offered under the supervision of appropriate interdepartmental committees.

**OTHER FIELDS**—Fields which have not been approved for either major or minor work, but in which approved courses are offered, are listed in Part II of this section. These courses may be used in graduate programs as electives or as part of a general studies program, subject to the approval of the major department and to the restrictions upon the use of 400 series courses in degree programs.

**COURSE NUMBERING SYSTEM**—Courses in the series 1-399 are not listed in this bulletin because they are strictly undergraduate courses and yield no graduate credit. A graduate student may register for or audit these courses in order to make

## PROGRAMS AND COURSES

up deficiencies or fill in gaps in his earlier education but not to meet requirements for an advanced degree.

Courses in the series 400-499 are for upperclassmen with at least junior standing and for graduate students. Only a limited number of credits earned in these courses may be counted toward the requirements for an advanced degree. Detailed regulations are given in the preceding section of this bulletin.

Courses in the series 500-599 are restricted to students registered in the Graduate School and other students who, in exceptional cases, have been granted permission to enroll by the Dean of the Graduate School.

Course numbers 600 and 610 apply to research and thesis and are available only to students registered in the Graduate School.

**COURSE DESCRIPTIONS**—A course abbreviation, a number, and a title designate each course. Course designations and official abbreviations are listed at the left-hand margin just above the first course in each group. The figures in parentheses following the course title show the number of credits which may be granted for that course. In the case of courses with variable credits, the number of credits which may be earned in a single semester or session is determined by the department offering the course.

A department may schedule an entire section of a course below the 400 level for fewer credits than the maximum authorized. In 400 and 500 series courses a department may schedule an individual student for fewer credits than the maximum number but in no case for more than the maximum number authorized.

**SCHEDULE OF COURSES**—Not all courses are given each semester or session. A complete list of the courses which will be offered in any specific semester is given in the *Timetable*, which is available at nominal cost from the Registrar's Office a few weeks before the beginning of each semester. The *Timetable* gives the number of credits being offered in each course, the hours at which the class will meet, the location of the class, and in some cases the instructor's name.

The courses being offered during a specific summer session are given in the *Complete Announcement of the Summer Sessions* for that year. This announcement, which includes a timetable for summer sessions classes, may be obtained from the Summer Sessions office a few weeks before the beginning of the first session.

The list of courses given in the *Timetable* and the *Complete Announcement of the Summer Sessions* is subject to modification at registration time. The number enrolling in a course, the availability of staff members, and other circumstances may result in the cancellation of some courses and the offering of others. Decisions are made by the departments offering the courses.

**RESEARCH AND THESIS WORK**—In general, students registering for research or for work on a master's or a doctor's thesis will, if it is to be done in residence, use course number 600 preceded by the appropriate course abbreviation. Thus Aro.E. 600 signifies research or thesis in aeronautical engineering. In case such work has been authorized as off-campus work for nonresident students, the number 610 will be used. Credits will be 1 to 15 per semester.

It should be assumed that the numbers 600 and 610 are available during the academic year in all fields in which majors have been approved for advanced degrees although these numbers do not appear in the timetables. In the summer, however, research and thesis work are usually available only in those fields for which 600 and 610 numbers appear in the *Complete Announcement* and the *Summer Sessions Timetable* for that year.

MAJOR  
and  
MINOR  
FIELDS



## FIELDS IN WHICH BOTH MASTERS' AND DOCTORS' DEGREES ARE OFFERED

Aeronautical Engineering	Geology
Agricultural and Biological Chemistry	Geophysics
Agricultural Economics	German
Agricultural Education	Higher Education (D.Ed. only)
Agronomy	History
Animal Husbandry	Home Economics Education
Animal Nutrition	Home Management and Family Economics
Art Education	Horticulture
Bacteriology	Industrial Arts Education
Biological Science	Mathematics
Botany	Mechanical Engineering
Business Administration	Metallurgy
Business Education	Meteorology
Ceramic Technology	Mineral Economics
Chemical Engineering	Mineral Preparation
Chemistry	Mineralogy and Petrology
*Child Development	Mining Engineering
Civil Engineering	Music Education
Clinical Speech	Nutrition
Clothing and Textiles	Petroleum and Natural Gas Engineering
Comparative Literature	Philosophy
Counseling in Education	Physical Education
Dairy Science	Physics
Economics	Plant Pathology
Educational Administration	Political Science
Electrical Engineering	Poultry Husbandry
Elementary Education	Psychology
Engineering Mechanics	Recreation Education
English	Romance Languages and Literatures
Entomology	Rural Sociology
*Family Relationships	Secondary Education
Fuel Technology	Sociology
General Home Economics	Speech
Genetics and Breeding	Vocational Industrial Education
Geochemistry	Zoology
Geography	

## FIELDS IN WHICH ONLY A MASTER'S DEGREE IS OFFERED

Agricultural Engineering	Journalism
Architectural Engineering	Music
Architecture	Nuclear Engineering
Art	Nutrition in Public Health
*Child Development and Family Relationships	Physical Science
Foods	Public Administration
Forestry	Sanitary Engineering
Industrial Engineering	Social Studies
Institution Administration	Theatre Arts
	Wildlife Management

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\* See page 76, Child Development and Family Relationships.

*Part I*  
*Courses in Major and Minor Fields*

**AERONAUTICAL ENGINEERING**

IRVING MICHELSON, *Head of the Department*  
203 Engineering D

The department offers graduate programs leading to the M.S. and Ph.D. degrees. Course work and research are available in aerodynamics, structures, aeroelasticity, turbomachinery, and dynamics.

A student should have a bachelor's degree in engineering, mathematics, or physics to be admitted to graduate work in aeronautical engineering. He must have satisfactorily completed courses in statics, dynamics, strength of materials, and mathematics at least through ordinary differential equations but preferably through vector analysis.

**AERONAUTICAL ENGINEERING (ARO E)**

- 401a,b,c. AERONAUTICAL ENGINEERING PROJECTS (2-12)
- 402. DESIGN AND TESTING OF AIRCRAFT ENGINE COMPONENTS (3)
- 403. APPLIED AERODYNAMICS (3)
- 404. AIRPLANE DESIGN AND TESTING (3)
- 407. ROTARY WING AIRCRAFT (3)
- 408. AIRCRAFT GAS TURBINES AND JET PROPULSION ENGINES (3)
- 409. AIRCRAFT STRUCTURAL DETAIL DESIGN (3)
- 410. AIRCRAFT PROPULSION (3)
- 411. AEROELASTICITY (3)
- 412. THEORETICAL AERODYNAMICS (3)
- 413. AERONAUTICAL DYNAMICS (3)
- 414. AIRCRAFT PRELIMINARY DESIGN (3)
- 415. ADVANCED THEORETICAL AERODYNAMICS (3)
- 416. MISSILE SYSTEMS LECTURES (0)
- 417. MISSILE SYSTEMS LECTURES (0)
  
- 501. AIRPLANE STABILITY AND CONTROL (3) General analysis of longitudinal and lateral stability of airplanes; characteristics of flight control devices. Prerequisite: Aro.E. 403.
  
- 503. AIRPLANE PERFORMANCE (3) Methods of performance prediction and performance flight testing for high-speed aircraft and missiles. Prerequisite: Aro.E. 403.
  
- 504. ROTARY WING AIRCRAFT (3) Types of rotary wing aircraft; helicopter performance, stability, and control; structural and vibration problems. Prerequisites: Aro.E. 403, 409.
  
- 505. AEROELASTICITY (3) Vibrating systems with several degrees of freedom; analysis of flutter speed of an airplane wing considering bending, torsion, and aileron motions; other types of aircraft flutter. Prerequisites: Aro.E 412; E.Mch. 401 or Aro.E. 411.

## AERONAUTICAL ENGINEERING

506. AIRCRAFT STRUCTURES (3-9) Deflections of beams and trusses; statically indeterminate structures; shear-flow analysis and shearing deformations of multicell semi-monocoque structures; effects of discontinuities in wing and fuselage structures. Prerequisites: Aro.E. 409, E.Mch. 408.
507. AIRCRAFT GAS TURBINES AND JET PROPULSION ENGINES (3) Types of jet propulsion installations, thermodynamic cycles, analysis of compressors, combustion chambers, and turbines. Prerequisite: Aro.E. 410.
510. AERODYNAMICS OF COMPRESSIBLE FLUIDS (3) One-dimensional motion, shock waves, flow in nozzles, two-dimensional flow, airfoil theory, Prandtl-Meyer flow, method of characteristics. Prerequisite: Aro.E. 412.
511. AERODYNAMICS OF A PERFECT FLUID (3) Euler's dynamic equations, complex potential, conformal transformation, thin airfoils, Biot-Savart law; Prandtl three-dimensional airfoil theory. Prerequisite: Aro.E. 412.
512. AERODYNAMICS OF A VISCOUS FLUID (3) Navier-Stokes equations, incompressible and compressible boundary layer theory, jet and wake problems, hydrodynamic stability, turbulence. Prerequisite: Aro.E. 412.
513. RESEARCH IN AERONAUTICAL ENGINEERING (1-15 per semester) Investigation of a theoretical or experimental project in aeronautical engineering.
514. AERONAUTICAL ENGINEERING SEMINAR (1 per semester) Current literature and special problems in aeronautical engineering.
515. AERODYNAMICS (3) Airflow, airplane performance. For students with undergraduate training in science or engineering curriculums other than aeronautical engineering.
516. SPECIAL TOPICS IN AIRCRAFT STRUCTURES (3-9)
519. FLUID DYNAMICS OF ROTATING MACHINERY (3-6) Prerequisite: Aro.E. 412.
520. SPECIAL TOPICS IN AERODYNAMICS (3-9)

## AGRICULTURAL AND BIOLOGICAL CHEMISTRY

HOWARD O. TRIEBOLD, *Head of the Department*  
109 Frear Laboratory

Graduate work leading to the M.S. and Ph.D. degrees is offered. Opportunities for research and graduate study are available in plant metabolism and photosynthesis, intermediary metabolism, nucleic acids, proteins, carbohydrates, lipides, enzymes, vitamins, animal nutrition, poultry nutrition, clinical chemistry, endocrinology, and pesticides.

Entering graduate students should have had training which includes at least one year's work in each of the following: general chemistry, analytical chemistry, organic chemistry, physical chemistry, and general physics. Mathematics through integral calculus is also required. Students with limited deficiencies in these subjects may be admitted but must make up such deficiencies concurrently with their graduate studies. Undergraduate courses in biology, biochemistry, and foreign languages will be helpful to the student but are not required for admission.



# AGRICULTURAL AND BIOLOGICAL CHEMISTRY

## AGRICULTURAL AND BIOLOGICAL CHEMISTRY (AB CH)

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|-----------------------------------------------------|---------------------|
| 403. DAIRY CHEMISTRY (3)                            | <i>Mr. Shigley</i>  |
| 404. FOOD CHEMISTRY (4)                             | <i>Mr. Triebold</i> |
| 413. PRINCIPLES OF ANIMAL NUTRITION (3)             | <i>Mr. Miller</i>   |
| 417. METHODS OF AGRICULTURAL ANALYSIS (4)           | <i>Mr. Triebold</i> |
| 418. PLANT ANALYSIS (4)                             | <i>Mr. Clagett</i>  |
| 425. BIOPHYSICAL CHEMISTRY (4)                      | <i>Mr. Mallette</i> |
| 426. BIOCOLLOIDS (3)                                | <i>Mr. Mallette</i> |
| 427. POTENTIOMETRIC THEORY AND TECHNIQUE (3)        |                     |
| 437. GENERAL BIOCHEMISTRY (5)                       | <i>Mr. Pritham</i>  |
| 438. PHYSIOLOGICAL CHEMISTRY (CLINICAL METHODS) (5) | <i>Mr. Pritham</i>  |
| 439. PROBLEMS IN AGRICULTURAL CHEMISTRY (3-5)       |                     |
| 440. PLANT BIOCHEMISTRY (3)                         | <i>Mr. Clagett</i>  |
| 441. RADIOLOGICAL SAFETY (1)                        |                     |
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501. ENZYMES (2) Investigations and theories concerning nature of enzymes, enzyme action, influence of chemical environment on enzyme action, and biological applications. Prerequisite: A.B.Ch. 437. Fall semester. *Mr. Clagett*
502. PHYSICAL CHEMISTRY OF THE CELL (3) Lectures and assigned reading reviewing current literature relative to physical chemistry of living tissues and life processes. Prerequisite: A.B.Ch. 426.
503. BIOCHEMICAL PROBLEMS (1-10 per semester) Prosecution of an assigned problem under the guidance of an instructor. Each semester and summer session.
505. VITAMINS AND DIETARY DEFICIENCY DISEASES (2) Lectures, conferences, and assigned reading. Prerequisite: A.B.Ch. 437. Fall semester, odd years. *Mr. Guerrant*
506. VITAMIN ASSAY METHODS (2) Lectures, conferences, and demonstrations dealing with approved methods of vitamin assay including demonstrations of typical vitamin deficiency syndromes in the rat. Prerequisite: A.B.Ch. 505. Spring semester, even years. *Mr. Guerrant*
- 507a. SEMINAR IN PHYSIOLOGICAL CHEMISTRY AND NUTRITION (1 per semester)  
*Messrs. Guerrant, Boucher, Miller, and Pritham*
- 507b. SEMINAR IN FOODS AND ANALYTICAL CHEMISTRY (1 per semester) Fall semester.  
*Messrs. Triebold, Althouse, and Shigley*
- 507c. SEMINAR IN PLANT, ENZYME, AND INSECTICIDE CHEMISTRY (1 per semester)  
Spring semester. *Messrs. Frear, Benson, Mallette, and Clagett*
508. BIOCHEMICAL LITERATURE (1-3) Assigned readings, reports, and conferences on selected topics in biochemistry. Prerequisite: A.B.Ch. 437.
509. BIOCHEMICAL METHODS (3) Lectures and advanced laboratory on current techniques used in biochemical research. Prerequisites: Phys. 285, Chem. 461. Spring semester. *Messrs. Benson and Mallette*
510. PROTEINS, AMINO ACIDS, AND PEPTIDES (2) Organic, physical, and biological chemistry of the naturally occurring compounds of this group. Prerequisites: A.B.Ch. 425, 437. Fall semester. *Mr. Mallette*

## AGRICULTURAL AND BIOLOGICAL CHEMISTRY

511. CARBOHYDRATES (2) Chemical constitution and properties of carbohydrates; their metabolism in plant and animal organisms. Prerequisite: A.B.Ch. 437. Spring semester. *Mr. Benson*
512. LIPIDES (2) Investigations on biochemistry of fats and related substances. Spring semester. *Mr. Althouse*
513. PHYSICOCHEMICAL MEASUREMENTS USED IN BIOLOGICAL RESEARCH (4) Laboratory course, quantitative in nature, valuable as preparation for A.B.Ch. 502. Hydrogen-ion concentration, electrometric titration, buffers, oxidation-reduction potential, and membrane potential. Prerequisite: A.B.Ch. 425 or Chem. 463.
515. BIOMETRY (2) Application of statistical methods to research problems in biochemistry and biology. Prerequisite: Ag. 400. Spring semester, odd years. *Mr. Miller*
516. CHEMISTRY OF THE PESTICIDES (2) Lectures and assigned readings on the chemistry of insecticides, fungicides, herbicides, rodenticides, and related materials. Prerequisite: Chem. 31 or A.B.Ch. 437. Fall semester, even years. *Mr. Frear*
517. ENDOCRINE SECRETIONS (2) Chemistry of hormones and their physiological significance. Prerequisite: A.B.Ch. 437. Spring semester, even years. *Mr. Pritham*
518. MINERAL METABOLISM (2) Utilization and function of mineral elements in animal nutrition. Prerequisite: A.B.Ch. 437. Spring semester, odd years. *Mr. Boucher*

## AGRICULTURAL ECONOMICS

MACKLIN E. JOHN

*Head of the Department of Agricultural Economics and Rural Sociology*  
1 Weaver Building

A graduate program leading to the M.S. or Ph.D. degree may be taken in agricultural economics. The entering student in the master's program should have as prerequisites 3 credits in agricultural economics, 3 credits in economics, and 3 additional credits in either agricultural economics or economics. If a student lacks some of the prerequisites, he may take them without graduate credit during the early part of his master's program.

### AGRICULTURAL ECONOMICS (AG EC)

407. ADVANCED FARM MANAGEMENT (3) *Mr. Brandow*
420. AGRICULTURAL PRICES (3) *Mr. Frey*
421. LAND ECONOMICS (3) *Mr. Trotter*
426. (A.H. 426). LIVESTOCK MARKETING (3)
500. SEMINAR IN AGRICULTURAL ECONOMICS (1-6) Review of current literature and problems.
503. RESEARCH METHODS IN FARM MANAGEMENT (1-3) Evaluation of research procedures, methods, results, and needs in the field; emphasis on their application to specific research problems. Prerequisites: Ag.Ec. 6, Econ. 14.
504. AGRICULTURAL PRICE AND INCOME POLICY (3) Analysis of farm prices, income consequences for producers and consumers, and effects on resource use; evaluation

## AGRICULTURAL ECONOMICS

- of policy, considerations in policy making. Prerequisites: Ag.Ec. 420, Econ. 405.  
*Mr. Bradow*
505. **ADVANCED AGRICULTURAL STATISTICS (3)** Multiple correlation, curve fitting, analysis of variance, selection of samples, and other techniques applicable to the rural social sciences. Prerequisite: 3 credits in statistics.  
*Mr. Bennett*
506. **ECONOMIC PROBLEMS IN MARKETING SPECIFIC AGRICULTURAL PRODUCTS (3)** Profit maximization; psychological and sociological aspects of selling; engineering aspects of cost reduction; techniques in developing information for managerial decisions.
507. **SEMINAR IN FARM MANAGEMENT (1-6)** Special problems relating to organization and operation of the farm business. Prerequisites: Ag.Ec. 6, Econ. 14.
510. **ADVANCED FARM FINANCE (1-3)** Problems and policies in agricultural credit, insurance, and farm financial management.
515. **ECONOMIC PROBLEMS IN THE MARKETING OF DAIRY PRODUCTS (3)** Economic problems as they are encountered in the process of marketing; particular attention to governmental regulation in pricing and marketing.  
*Mr. Pierce*
517. **PROBLEMS AND POLICIES OF FARMER CO-OPERATIVES (3)** Specific types of co-operative organizations, their problems, policies, and progress; relationships existing among co-operatives, between co-operatives and other business organizations, and between co-operatives and the public. Prerequisite: Ag.Ec. 17.  
*Mr. Becker*
520. **FARM PRICE ANALYSIS (3)** Econometric analysis of prices, production, and utilization of farm products; review of research in this field. Prerequisites: Ag.Ec. 420, 505; Econ. 405.  
*Mr. Bradow*
522. **ADVANCED FARM APPRAISAL (3)** Land value theory; methods of land valuation; field practice in farm appraisal.  
*Mr. Frey*
525. **RESEARCH METHODS IN RURAL SOCIAL SCIENCES (2)** Scientific method in planning and conducting research. Prerequisite: 9 credits in social sciences. *Mr. John*
526. **RESEARCH METHODS IN AGRICULTURAL ECONOMICS (2)** Application of economic and statistical principles.  
*Mr. Baker*
534. **AGRICULTURAL PRODUCTION ECONOMICS (3)** Economic theory applied to agricultural production problems: resource combination, firm size, uncertainty and expectations, aggregate aspects of production, technological change.
535. **SEMINAR IN AGRICULTURAL MARKETING (2)**
536. **SEMINAR IN DAIRY ECONOMICS (1 per semester)**

## AGRICULTURAL EDUCATION

HENRY S. BRUNNER, *Head of the Department*  
101 Agricultural Education Building

Graduate programs are offered which lead to the M.Ed., M.S., D.Ed., and Ph.D. degrees. Minors may be taken in any of the areas of agricultural technology, or, for Master of Science and Doctor of Philosophy degree candidates, in one of the other fields of education, such as educational administration or higher education.



## AGRICULTURAL EDUCATION

The requirements for admission are 21 semester hours in professional education courses including educational psychology and practice teaching in vocational agriculture, or certification to teach vocational agriculture. Students who lack any part of these requirements may be admitted but are required to fulfill deficiencies without degree credit.

### AGRICULTURAL EDUCATION (AG ED)

- 417v. RURAL EDUCATION SURVEY (2) *Mr. Hoover*  
418v. SURVEY OF VOCATIONAL EDUCATION IN AGRICULTURE (1-3) *Mr. Hoover*  
420v. ADVANCED VISUAL AND OTHER SENSORY AIDS IN TEACHING AGRICULTURE (1-6) *Mr. Anthony*  
422v. SUPERVISION OF VOCATIONAL EDUCATION IN AGRICULTURE (1-3) *Mr. Anthony*  
434v. AGRICULTURAL DEVELOPMENTS (1-6) *Mr. Hoover*
- 501v. HISTORY OF AGRICULTURAL EDUCATION (1-3) Development of training for agricultural vocations; emphasis upon introduction of agricultural instruction into the high school program. *Mr. Brunner and Staff*
- 502v. TEACHING VOCATIONAL AGRICULTURE (1-3) Organization of instruction with respect to vocation objectives, methods of presentation, supervision of practice, pupil evaluation of goals, and follow-up. *Mr. Brunner*
- 503v. RESEARCH IN AGRICULTURAL EDUCATION (1-6 per semester) Individual study problems in various phases of agricultural education, such as evaluation of teaching, teaching procedures, and teacher preparation. *Mr. Brunner and Staff*
- 504v. AGRICULTURAL EDUCATION SEMINAR (1 per semester) *Mr. Brunner and Staff*
- 506v. PROBLEMS IN COUNTY VOCATIONAL SUPERVISION (1-3) Needs of county supervisors and vocational directors; co-operation with county superintendents, supervisory duties, plans of work, community meetings and organizations. *Mr. Hoover*
- 508v. STATE AND COUNTY ADMINISTRATION AND SUPERVISION OF AGRICULTURAL EDUCATION (1-3) Organization and administration of state, county, township, and district systems of agricultural education; state and federal legislation. *Mr. Stevens*
- 509v. TEACHER TRAINING IN AGRICULTURAL EDUCATION (1-6) Construction of college curriculums, courses of study, and organization of college departments for training agricultural teachers. *Mr. Brunner*
- 520v. SCIENTIFIC METHOD IN THE STUDY OF AGRICULTURAL EDUCATION (1-4) Methods of procedure in investigation and experimentation in education, accompanied by a critical examination of studies made in agricultural education. *Mr. Stevens*
- 521v. SCIENTIFIC METHOD IN THE STUDY OF AGRICULTURAL EDUCATION (1-4) Continuation of Ag.Ed. 520v; emphasis upon statistical techniques for students' individual problems. *Mr. Stevens*
- 522v. FIELD STUDIES IN AGRICULTURAL EDUCATION (1-4) Organization and administration of agricultural education in its local bearings; field laboratory surveys of local school conditions. *Mr. Brunner and Staff*
- 523v. FIELD STUDIES IN AGRICULTURAL EDUCATION (1-4) *Mr. Brunner and Staff*

## AGRICULTURAL EDUCATION

- 524v. ANNUAL PLAN OF WORK (1-3) Detailed study of the agricultural education needs of each student's community and outlining annual plans of work.

*Mr. Brunner*

- 530v. AGRICULTURAL COLLEGE TEACHING (3) Selection and organization of subject matter for specific courses, methods of learning, teaching devices, technique of teaching, and measurements of results of teaching.

*Mr. Brunner*

## AGRICULTURAL ENGINEERING

FRANK W. PEIKERT, *Head of the Department*  
204 Agricultural Engineering Building

The department offers major work for the M.S. degree with specialization in farm power and machinery, electric power and processing, soil and water conservation engineering, and farm structures.

Prerequisite to major work is the completion of an undergraduate curriculum in agricultural engineering from a recognized department.

### AGRICULTURAL ENGINEERING (AG E)

400. AGRICULTURAL ENGINEERING PROBLEMS (1-7)
401. FARM MECHANICS FOR TEACHERS OF VOCATIONAL AGRICULTURE (1½-9)  
*Unit A. Farm Utilities (1½)*  
*Unit B. Farm Mechanics (1½)*  
*Unit C. Farm Engines (1½)*  
*Unit D. Farm Machinery (1½)*  
*Unit E. Farm Buildings (1½)*  
*Unit F. Soil and Water Structures (1½)*
402. FUNCTIONAL DESIGN OF FARM STRUCTURES (3)
405. ADVANCED FARM ELECTRIFICATION (3)
406. ADVANCED DAIRY ENGINEERING (3)
500. ADVANCED ELECTRO-AGRICULTURE (1-6) Investigations in the application of electrical energy to processing, storing, and handling agricultural products. Seminar, written reports.
501. ADVANCED FARM MACHINERY (1-6) Application of agricultural engineering principles to design and operation of farm machinery. Prerequisite: Ag.E. 110.
502. FARM STRUCTURES PROBLEMS (1-6) Analysis of farm structures design problems.
507. PROBLEMS IN SOIL WATER ENGINEERING (1-6) Analysis of engineering problems relating to irrigation, drainage, or erosion control.
508. ADVANCED PROBLEMS IN FARM MECHANICS (1-15) Problems in farm shop practice and agricultural engineering related to the farm mechanics program of vocational education in agriculture. Prerequisites: Ag.E. 8, 14; or teaching experience in farm mechanics.
509. RESEARCH IN AGRICULTURAL ENGINEERING (1-4)
520. AGRICULTURAL ENGINEERING SEMINAR (1-3) Reports on research and special topics.

## AGRONOMY

HOWARD B. SPRAGUE, *Head of the Department*  
118 Tyson Building

Graduate work leading to the M.S. and Ph.D. degrees is offered. Areas of specialization for each degree include soil chemistry; soil conservation; soil classification; soil fertility; soil mineralogy; soil physics; the breeding of corn, small grains, and forage plants; forage management; turf management; potato culture; tobacco culture; weed control; and ecology of crops and pastures. Facilities are available for X-ray diffraction, infrared and petrographic investigations of soils.

Prerequisites for major work in agronomy vary with the area of specialization, but basic courses in chemistry, mathematics, physics, and biological sciences are required. Students who lack some of the course prerequisites may be admitted but are required to take the prerequisite courses without degree credit.

## AGRONOMY (AGRO)

- |                                              |                                     |
|----------------------------------------------|-------------------------------------|
| 411. BREEDING OF FIELD CROPS (3)             | <i>Mr. Cleveland</i>                |
| 416. SOIL CLASSIFICATION (5)                 | <i>Mr. Higbee</i>                   |
| 417. FOREST SOILS (3)                        |                                     |
| 419. SOIL PROPERTIES (5)                     | <i>Mr. Satchell</i>                 |
| 422. SOIL CONSERVATION (3)                   | <i>Mr. Kardos</i>                   |
| 423. PASTURE AND GRASSLAND MANAGEMENT (3)    | <i>Mr. Washko</i>                   |
| 424. FERTILIZER TECHNOLOGY (3)               | <i>Mr. Marriott</i>                 |
| 429. (Bot. 429). WHITE POTATO PRODUCTION (3) | <i>Messrs. Harrington and Mills</i> |
| 490. AGRONOMIC PRACTICES (1-6)               | <i>Mr. Washko and Staff</i>         |
501. ADVANCED SOIL FERTILITY (4) Interpretation of fertility experiments and diagnosis of soil-plant relationships through field appraisal, analysis, and plant symptoms. Prerequisites: Agro. 31, Bot. 406. Spring semester, odd years. *Mr. Hunter*
503. AGRONOMY SEMINAR (1) Weekly meeting where papers and discussions will be presented by students and staff members. *Mr. H. B. Sprague*
506. SOIL CHEMISTRY (4) Analyses of important chemical and biochemical reactions occurring in soils, conditions which control these reactions and their importance in soil genesis and plant growth; laboratory work in the more typical and significant analytical procedures; lectures, review of current literature, and practicum. Prerequisites: Agro. 419; A.B.Ch. 417 or Chem. 20. Spring semester, even years. *Mr. Satchell*
507. SOIL PHYSICS (4) Physical properties of the soil; factors affecting them; their measurements, evaluation, and influence in determination of soil productivity. Prerequisites: Agro. 419, Phys. 215, A.B.Ch. 425. Fall semester, even years. *Mr. Kardos*
509. GENETICS OF CROP PLANTS (3) Inheritance in crop plants with particular reference to factor interaction, genetic aspects of linkage and crossing-over, quantitative inheritance, and heterosis. Prerequisite: Bot. 422. Fall semester, even years. *Mr. Cleveland*
510. THE APPLICATION OF CYTOGENETICS TO PLANT BREEDING (3) Cytogenetics, including chromosome structure and behavior, chromosome alterations, polyploidy, interspecific hybridization and their applications to plant breeding. Prerequisite: Bot. 422. Fall semester, odd years. *Mr. Cleveland*



512. **FIELD PLOT TECHNIQUE** (4) Ramifications of analysis of variance techniques; combining and analyzing data from several experiments; selection of valid error terms. Prerequisite: Math. 8 or Ag. 400. Fall semester.
516. **HUMUS** (2) Origin and chemical nature of soil organic matter, its importance in soil processes, and its decomposition. Prerequisites: Agro. 31, 419. Fall semester, odd years. *Mr. Richer*
517. **FARM CROPS ECOLOGY** (2) Ecological factors influencing distribution and production of field crops. Prerequisites: Math. 8, Bot. 406. Fall semester, even years.
518. **GROWTH AND MANAGEMENT OF FORAGE CROPS** (3) Factors affecting growth and development of forage crops with particular reference to effects of environment, defoliation, and management practices. Prerequisites: Agro. 423, Bot. 406. Spring semester, odd years.
519. **THE NATURE OF SOIL MINERALS** (3) Modern methods for identification of the constituent minerals of soils and their relation to soil classification and agricultural practices. Prerequisites: Agro. 1, Chem. 2, Geol. 31. Spring semester, even years. *Mr. Jeffries*
520. **SPECIAL SOILS PROBLEMS** (1-6 per semester) Provides basic or practical training in the soils sciences by means of library, field, and laboratory assignments.
545. **THE APPLICATION OF STATISTICS TO FIELD EXPERIMENTS** (4) Use of advanced experimental designs in planning, analyzing, and interpreting experiments; includes lattice designs, factorials, confounding, simple and multiple covariance techniques. Prerequisite: Agro. 512. Spring semester.
550. **SPECIAL CROPS PROBLEMS** (1-6 per semester) Provides basic or practical training in the crops sciences by means of library, field, and laboratory assignments.
582. **SEMINAR IN THE BREEDING AND GENETICS OF FARM CROPS** (1-8 per semester)
583. **LABORATORY METHODS IN AGRONOMIC RESEARCH** (3) Prerequisite: Agro. 512. Summer only.

## ANIMAL HUSBANDRY

GLENN R. KEAN, *Acting Head of the Department*  
203 Armsby Building

The department offers major work for the M.S. and Ph.D. degrees with specialization in animal production, animal breeding, and meats.

The prerequisite for major graduate work in animal husbandry is the completion of an undergraduate curriculum in animal husbandry or a related animal science area. Students who lack some of the course prerequisites may be admitted but are required to take the prerequisite courses without degree credit.

### ANIMAL HUSBANDRY (A H)

421. **ADVANCED MEAT STUDIES** (3)
423. **ADVANCED STOCK JUDGING** (2)
424. **ANIMAL HUSBANDRY SEMINAR** (1)
426. (Ag.Ec. 426). **LIVESTOCK MARKETING** (3)
431. **ADVANCED MEAT JUDGING** (2)

## ANIMAL HUSBANDRY

500. SEMINAR IN ANIMAL HUSBANDRY (1-6)
501. PEDIGREE STUDY (1-6) Research work in breed study history, and analytical study of breed pedigrees, and a complete survey of the herd, flock, or stud book.
502. RESEARCH IN MEATS (1-6 per semester) Investigation of methods for handling, cutting, processing, freezing, and curing meat and meat products. Prerequisite: A.H. 421.
503. LIVESTOCK MANAGEMENT (3) Handling of purebred herds and flocks; relation of livestock breeders to the public and methods of developing purebred herds and flocks through careful breeding.
505. ADVANCED ANIMAL BREEDING (1-5) Special problems in animal genetics as applied to breeding and improvement of horses, cattle, sheep, and swine. Prerequisites: A.H. 22, Bot. 22.

## ANIMAL NUTRITION

RAYMOND W. SWIFT, *Head of the Department*  
21 Armsby Building

The M.S. and Ph.D. degrees are offered with a major in animal nutrition. For admission a student must have had A.Ntr. 401 and 402 or their equivalent and must have met the requirements for graduate work in agricultural and biological chemistry. Specialized training is offered in the area of energy metabolism. Candidates select courses for this major from a number of related fields.

### ANIMAL NUTRITION (A NTR)

401. PHYSIOLOGY OF NUTRITION (3)  
402. PHYSIOLOGY OF NUTRITION (3)

*Mr. Barron*  
*Mr. Barron*

## ARCHITECTURE

MILTON S. OSBORNE, *Head of the Department*  
302 Sackett Building

The department offers graduate work leading to the M.S. degree with a major in architecture. To enter this field, a degree of Bachelor of Architecture, Bachelor of Science in Architecture, or Bachelor of Fine Arts in a five-year curriculum in architecture is required.

Graduate work may also lead to the M.S. degree with a major in architectural engineering. To enter this field, a degree of Bachelor of Architectural Engineering or Bachelor of Science in Architectural Engineering in a five-year curriculum is required.

### ARCHITECTURE (ARCH)

411. ADVANCED ARCHITECTURAL DESIGN (8)  
412. ADVANCED ARCHITECTURAL DESIGN AND THESIS (8)  
421. (A.A.H. 421). CONTEMPORARY ARCHITECTURE (3)
501. ARCHITECTURAL DESIGN (4-8) Problems in advanced planning and design, including study of group composition. Practicum and seminar.

*Mr. Osborne and Staff*

## ARCHITECTURE

502. ARCHITECTURAL RESEARCH (2-12) Prosecution of assigned problems under the guidance of an instructor. *Mr. Osborne and Staff*
503. ARCHITECTURAL HISTORY RESEARCH (3-12) Original research in architectural history. Seminar and written reports. *Mr. Dickson and Staff*

### ARCHITECTURAL ENGINEERING (A E)

401. ARCHITECTURAL ENGINEERING (3)  
402. ARCHITECTURAL ENGINEERING (4)  
403. ARCHITECTURAL ENGINEERING (3)  
420. ARCHITECTURAL ENGINEERING (3)  
421. ARCHITECTURAL ENGINEERING (4)  
422. ARCHITECTURAL ENGINEERING (3)  
423. ARCHITECTURAL ENGINEERING THESIS (2)  
424. ARCHITECTURAL ENGINEERING THESIS (5)
502. ARCHITECTURAL ENGINEERING (3-8) Advanced structural design in steel and reinforced concrete. Lectures and class criticism. Practicum and seminar. *Mr. Richardson and Staff*
503. ARCHITECTURAL ENGINEERING (4-8) Continuation of A.E. 502 in which problems of wind bracing in tall buildings, rigid frames, and heavy-framed constructions are studied. Practicum and seminar. *Mr. Richardson and Staff*
504. ARCHITECTURAL ENGINEERING (4-8) Statically indeterminate stresses in steel and reinforced concrete buildings; area moment, slope deflection, and moment distribution methods. Recitation and seminar. *Mr. Richardson and Staff*

## ART

Graduate work leading to the M.A. degree is offered in this field. Students may specialize in studio work or the history of art and architecture, or may combine the two areas to satisfy the major requirements.

For admission at least 18 credits of undergraduate work in art are required. The graduate program is contingent upon the student's undergraduate preparation. If an inadequacy exists, the student will be required to make up the deficiency without degree credit.

### ART (ART)

400. ADVANCED OIL PAINTING (3-12)  
410. WATER-COLOR PAINTING: LANDSCAPE, STILL LIFE, AND FIGURE (3-9)  
420. APPLIED DESIGN (3-9)  
431. SCULPTURE (2-6)  
440. PRINTMAKING (2-6)  
490. LIFE DRAWING (3)
500. ART RESEARCH (2-6) Prosecution of assigned problems under the guidance of an instructor.
510. ADVANCED PAINTING (2-12)



## ART

531. ADVANCED SCULPTURE (2-12)

540. ADVANCED PRINTMAKING (2-12)

## ART AND ARCHITECTURAL HISTORY (A A H)

421. (Arch. 421). CONTEMPORARY ARCHITECTURE (3)

448. HISTORY OF PRINTS AND DRAWINGS (3)

501. ITALIAN PAINTING (2-6) Investigations of early Italian painting. Seminar, written reports. *Mr. Dickson*

502. MEDIEVAL SCULPTURE (2-6) Sculpture of Italy and France from the 9th to the 13th centuries. Seminar, written reports. *Mr. Norton*

503. ART HISTORY RESEARCH (3-12) Original investigation in art history, to be pursued independently or concurrently with course work in particular fields. Prerequisite: 6 credits in history of art.

504. SEMINAR: ART LITERATURE AND ICONOGRAPHY (2-6) Methods of research in the fine arts; survey of the literature of art; studies in iconography. Prerequisite: 6 credits in history of art.

## ART—MUSIC—THEATRE (A M T)

400. CONTEMPORARY FORMS IN ART, MUSIC, THEATRE I (3)

401. CONTEMPORARY FORMS IN ART, MUSIC, THEATRE II (3)

## ART EDUCATION

VIKTOR LOWENFELD, *Head of the Department*  
207B Burrowes Building

Advanced work leading to the M.Ed., M.S., D.Ed., and Ph.D. degrees is offered. It is generally expected that students admitted to work toward a master's degree have one year of teaching experience and present the equivalent of an approved four-year art education curriculum. A student may not receive his doctor's degree without having had at least two years of successful teaching experience.

## ART EDUCATION (A ED)

402. PROFESSIONAL ORIENTATION OF THE ART TEACHER (3)

*Mr. Mattil*

404. METHODS OF GRAPHICS AND ILLUSTRATIONS (3)

414. ADVANCED CRAFTS FOR TEACHERS (3-6)

*Mr. Chomicky*

420. CERAMICS FOR TEACHERS (3)

*Mr. Beittel*

434. ART APPRECIATION IN THE EDUCATIONAL PROGRAM (3)

*Mr. Beittel*

434b. ART IN THE ELEMENTARY SCHOOL (2-3)

*Mr. Lowenfeld*

434c. ART IN THE SECONDARY SCHOOL (3)

*Miss Godfrey*

434d. ART SUPERVISION (3)

*Mr. Mattil*

486. CURRENT PROBLEMS IN ART EDUCATION (2-3)

*Mr. Mattil*

487. MURAL PAINTING IN SCHOOLS (3)

*Mr. Lowenfeld*

488. ADVANCED MURAL PAINTING IN SCHOOLS (3)

*Mr. Lowenfeld*

489. ART EXPERIENCES WITH CHILDREN (3)

*Mr. Mattil, Mrs. Yeager*

504. **ADVANCED METHODS IN GRAPHIC PROCESSES** (3) Exploration through laboratory experience of printing method: etching, silk screen, linoleum, or other; applications in teaching.
514. **FUNCTIONAL RELATIONSHIPS IN CRAFTS** (3) Relationships of material design and purpose in crafts discussed by means of outstanding products of different materials, periods, and cultures. Prerequisite: 6 credits in crafts or 3 in design and 3 in advanced crafts. *Mr. Pappas*
516. **ANALYSIS OF THREE-DIMENSIONAL PROCESSES IN ART** (3) Three-dimensional processes analyzed with regard to kinetic, textural, form, and other functions.
534. **CREATIVE ART ACTIVITY FOR THE HANDICAPPED** (3) Specific methods for development of creative art activity with the physically, mentally, emotionally, and socially handicapped; adjustive effect upon them. Prerequisite: 6 credits in art education or 6 in special education or 6 in psychology. *Mr. Lowenfeld*
586. **RESEARCH IN ART EDUCATION** (3-9) Current experiments in art education; required of students working for a master's degree in art education. *Mr. Beittel*
588. **HISTORY OF ART EDUCATION** (3) Historical development of philosophies in art education in the United States and abroad. *Mr. Lowenfeld*

## BACTERIOLOGY

ROBERT W. STONE, *Head of the Department*  
204 Patterson Building

Graduate work leading to the M.S. and Ph.D. degrees is offered. Specialized areas of study include bacterial physiology, soil microbiology, food and industrial microbiology, immunology, and virology. There is opportunity for research in animal disease in co-operation with the Department of Veterinary Science.

Prerequisites for graduate work are 20 semester hours of chemistry including quantitative analysis and organic chemistry, and 20 semester hours of biological science including 8 hours of microbiology. It is possible to substitute additional chemistry credits for part of the biology requirement.

### BACTERIOLOGY (BACT)

401. **GENERAL MICROBIOLOGY** (4)
407. **BACTERIOLOGY PROBLEMS** (2-9)
410. **IMMUNOLOGY AND SEROLOGY** (4)
411. **BACTERIOLOGICAL SURVEY** (1)
412. **ADVANCED BACTERIOLOGY** (4)
413. **SOIL MICROBIOLOGY** (3)
414. **FOOD MICROBIOLOGY** (4)
416. **INDUSTRIAL MICROBIOLOGY** (4)
506. **RESEARCH** (1-15 per semester) Special problems in microbiology.
507. **SEMINAR** (1 per semester) Reports on current fields of research.
508. **PHYSIOLOGY OF BACTERIA** (2) Composition, nutrition, and growth of microorganisms; influence of physical and chemical environment on metabolism.

## BACTERIOLOGY

- 508a. LABORATORY IN PHYSIOLOGY OF BACTERIA (2) Laboratory work to accompany the lectures given in Bact. 508.
509. FERMENTATION (2) Chemical activities of microorganisms; mechanisms of fermentative and oxidative metabolism.
510. LABORATORY IN FERMENTATION (2) Laboratory procedures and problems in fermentation to accompany Bact. 509.
512. BACTERIOLOGICAL TECHNIQUES (1-6) Practice in special laboratory techniques including manometry, tissue culture, and serology.
515. (V.Sc. 515). VIROLOGY (2-4) Rickettsial and viral agents parasitizing man, animals, and microorganisms. Prerequisite: Bact. 410.
516. BACTERIAL GENETICS (2-4) Mechanisms of variation in microorganisms including mutation, adaption, sexual recombination, transduction, and transforming factors. Prerequisite: 3 credits each in bacteriology and genetics.

## BIOLOGICAL SCIENCE

LEON R. KNEEBONE, *Chairman of the Committee on Biological Science*  
117 Buckhout Laboratory

The M.Ed. and D.Ed. degrees are offered with a major in biological science. The program is designed to meet the needs of secondary school science teachers.

The candidate for the M.Ed. degree must take at least 24 credits in the biological sciences. As many as 9 of these may be taken in the physical sciences and/or mathematics. In addition, at least 6 credits in basic education are required.

In order to enter a program for a higher degree with a major in biological science, the candidate should present 30 credits in the natural sciences, including at least one year of chemistry, and 27 credits in education, including educational psychology and practice teaching. As many as 6 credits may be made up as undergraduate deficiencies after the candidate is admitted to the Graduate School.

The M.S. degree is offered in agricultural and biological chemistry, bacteriology, botany, entomology, genetics and breeding, plant pathology, and zoology, but not in the broad field of biological science.

## BOTANY

JESSE E. LIVINGSTON  
*Head of the Department of Botany and Plant Pathology*  
206 Buckhout Laboratory

The M.S. and Ph.D. degrees are offered in the field of botany. The student majoring in botany may specialize in any one of the branches of this subject, such as plant anatomy, cytology, ecology, genetics, morphology, mycology, physiology, and taxonomy. In order to enter graduate work in this field, a student should present 27 credits of undergraduate work in botany or 21 credits in botany and 6 in biological science. As many as 6 credits may be made up as undergraduate deficiencies after the candidate has been admitted to the Graduate School.



In addition to its excellent facilities for research in various phases of botany, genetics, and plant pathology, the department is now equipped with a Gamma Radiation Laboratory for the study of irradiation effects upon plants, and other facets of radiation biology.

See also "Plant Pathology" and "Genetics and Breeding."

BOTANY (BOT)

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| 405. (Zool. 405). GENERAL CYTOLOGY (3)                                                                                                                                                                                                                                                 | Mr. Grun                           |
| 406. PLANT PHYSIOLOGY (4)                                                                                                                                                                                                                                                              | Mr. Fritz                          |
| 407. PLANT ANATOMY (3)                                                                                                                                                                                                                                                                 | Mr. Kribs                          |
| 408. PLANT PATHOLOGICAL TECHNIQUES (3)                                                                                                                                                                                                                                                 | Mr. Bloom                          |
| 409. PLANT ECOLOGY (3)                                                                                                                                                                                                                                                                 | Mr. Kovar                          |
| 412. ADVANCED FOREST PATHOLOGY (3)                                                                                                                                                                                                                                                     | Mr. Fergus                         |
| 414. TAXONOMY OF VASCULAR PLANTS (3)                                                                                                                                                                                                                                                   | Mr. Wahl                           |
| 415. MORPHOLOGY OF THE ALGAE (3)                                                                                                                                                                                                                                                       | Mr. Wahl                           |
| 416. MORPHOLOGY OF THE BRYOPHYTES (2)                                                                                                                                                                                                                                                  | Mr. Grove                          |
| 417. MORPHOLOGY OF THE TRACHEOPHYTA EXCLUSIVE OF ANGIOSPERMS (3)                                                                                                                                                                                                                       | Mr. Grove                          |
| 418. BOTANICAL PROBLEMS (1-6)                                                                                                                                                                                                                                                          |                                    |
| 419. MYCOLOGY (3)                                                                                                                                                                                                                                                                      | Mr. Fergus                         |
| 420. MORPHOLOGY OF THE ANGIOSPERMS (3)                                                                                                                                                                                                                                                 | Mr. Grove                          |
| 421. BOTANICAL TECHNIQUE (3)                                                                                                                                                                                                                                                           | Mr. Grove                          |
| 422. (Zool. 422). ADVANCED GENETICS (3)                                                                                                                                                                                                                                                | Messrs. Wright, Grun, and Mitchell |
| 424. COMMERCIAL TROPICAL WOODS (3)                                                                                                                                                                                                                                                     | Mr. Kribs                          |
| 427. ADVANCED SYSTEMATIC BOTANY (1-6)                                                                                                                                                                                                                                                  | Mr. Wahl                           |
| 428. ADVANCED PLANT PATHOLOGY (2)                                                                                                                                                                                                                                                      | Mr. Bloom                          |
| 429. (Agro. 429). WHITE POTATO PRODUCTION (3)                                                                                                                                                                                                                                          | Mr. Mills                          |
| 433. (Zool. 433). GENETICS, EUGENICS, AND EVOLUTION FOR TEACHERS (3)                                                                                                                                                                                                                   | Messrs. Wright, Grun, and Mitchell |
| 500. PLANT PHYSIOLOGY SEMINAR (1 per semester) Selected topics from recent literature; staff and student reports on current research. Spring semester, even years.                                                                                                                     |                                    |
|                                                                                                                                                                                                                                                                                        | Mr. Fritz                          |
| 501. THE PHYSIOLOGY OF THE FUNGI (3) Chemical composition, metabolism, toxic and stimulating agencies, spore germination, growth and irritability of the fungi. Prerequisites: Bot. 406, 419, and preferably Chem. 32. Fall semester, even years.                                      |                                    |
|                                                                                                                                                                                                                                                                                        | Mr. Fergus                         |
| 505. (Zool. 505). CYTOLOGY AND CYTOGENETICS (3) Chromosome mechanism of heredity; relationship between plant and animal evolution and breeding and changes in chromosomes; cytological and cytochemical techniques. Prerequisite: Bot. or Zool. 405 or 422. Fall semester, even years. |                                    |
|                                                                                                                                                                                                                                                                                        | Mr. Grun                           |
| 506. COMPARATIVE ANATOMY OF VASCULAR PLANTS (3) Structure of the Tracheophyta from a phylogenetic standpoint. Prerequisite: Bot. 407. Spring semester, even years.                                                                                                                     |                                    |
|                                                                                                                                                                                                                                                                                        | Mr. Kribs                          |
| 509. PHYSIOLOGY OF PATHOGENICITY (3) Physiological processes of plant pathogenic bacteria and fungi occurring during incubation, ingress, and infection. Prerequisite: Bot. 10, 11, or 419. Fall semester, even years.                                                                 |                                    |
|                                                                                                                                                                                                                                                                                        | Mr. Schein                         |
| *511. PHYSIOLOGY OF PLANT GROWTH AND DEVELOPMENT (2-4) Prerequisite: Bot. 406. Spring semester, every 2 or 3 years.                                                                                                                                                                    |                                    |
|                                                                                                                                                                                                                                                                                        | Mr. Fritz                          |

\* Credits to be arranged, 2 or 4.

## BOTANY

- \*512. PHYSIOLOGY OF PLANT METABOLISM (2-4) Prerequisite: Bot. 406. Fall semester, even years. *Mr. Fritz*
- \*513. WATER AND MINERAL RELATIONS OF PLANTS (2-4) Absorption of water and minerals; transport of materials within the plant; physiology of transpiration. Prerequisite: Bot. 406. Fall semester, odd years. *Mr. Fritz*
515. DISEASE RESISTANCE IN PLANTS (2-4) Stability of resistance, selection of resistant material, economics of control, special problems. Prerequisites: Bot. 22 or 33; 10. Fall semester, odd years. *Messrs. Wernham and Mills*
518. BOTANICAL PROBLEMS (1-15 per semester)
519. PLANT VIRUSES (3) Nature, symptomatology, transmission, and control of virus diseases of plants. Fall semester, even years. *Mr. Boyle*
520. PLANT PATHOGENIC BACTERIA (3) Bacteria causing plant diseases; methods of identification, inoculation, and control. Spring semester, odd years. *Mr. Kneebone*
521. MOLDS, YEASTS, AND ACTINOMYCETES (3) Morphology and taxonomy of fungi important in microbiology; identification and techniques of study. Spring semester, even years. *Mr. Fergus*
522. MYXOMYCETES, PHYCOMYCETES, AND ASCOMYCETES (4) Morphology, taxonomy, phylogeny, and life histories; identification and field work. Prerequisite: Bot. 419. Fall semester, odd years. *Mr. Fergus*
523. BASIDIOMYCETES AND FUNGI IMPERFECTI (4) Morphology, taxonomy, phylogeny, and life histories. Prerequisite: Bot. 419. Spring semester, even years. *Mr. Fergus*
524. (Zool. 524). SEMINAR IN GENETICS (1 per semester) *Messrs. Wright, Grun, and Mitchell*
- 525a,b. STRUCTURE OF ECONOMIC PLANTS (3 each) Developmental and reproductive features of (a) field and vegetable crops, (b) fruit crops. Bot. 525a, spring semester, odd years; 525b, spring semester, even years. *Mr. Grove*
526. PHOTOMICROGRAPHY OF PLANT TISSUES (2) Prerequisite: Bot. 421 or Zool. 31 or W.U. 37. Spring semester, even years. *Mr. Kribs*
- 527a,b. PLANT BIOLOGY FOR TEACHERS (3 each) (a) Structure and physiology; (b) reproduction processes, development and relationships of plant groups. Methods of obtaining materials and setting up experiments. Designed for teachers and prospective teachers. Prerequisite: general biology or general botany courses. Summer only; a and b given in alternate years.
528. (Zool. 528). POPULATION GENETICS (3) Factors affecting gene frequency, genotype frequency, genotype-environmental interaction, and genetic relationship in natural and artificial populations. Fall semester, odd years. *Mr. Mitchell*
529. DISEASES OF FORAGE CROPS (3) Etiology, symptomatology, and epidemiology of the more important diseases of forage grasses and legumes; critical evaluation of techniques of control. Spring semester, even years. *Mr. Couch*

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\* Credits to be arranged, 2 or 4.

530. PLANT DISEASE CONTROL (3) Methods, and laboratory and field testing of materials used in plant disease control. Spring semester, even years. *Mr. Fink*
531. PLANT PATHOLOGY SEMINAR (1 per semester) Selected topics of current research, history, and contemporary trends in plant pathology.
533. (Zool. 533). PROBLEMS IN GENETICS (2-6) Problems to suit needs of individual students; conferences and laboratory work. Prerequisite: Bot. or Zool. 422. *Messrs. Wright, Grun, and Mitchell*
537. (Ed. 537, Zool. 537). WORKSHOP IN THE BIOLOGICAL SCIENCES (3) Projects designed for teachers of biology in the secondary schools. Summer only.

## BUSINESS ADMINISTRATION

LAWRENCE E. FOURAKER

*In Charge of Graduate Programs in Business Administration*  
128 Boucke Building

Programs are offered leading to the M.S. and Ph.D. degrees with a major in business administration, and specialization in accounting, banking and finance, insurance and real estate, management, marketing, or trade and transportation. There is also a general major at the master's level for students whose undergraduate training was not business administration.

A minimum of 18 acceptable undergraduate credits in the fields of accounting, commerce, economics, and business statistics—including at least 6 in economics and 3 in business statistics—is required. An applicant who is slightly deficient in the required course work may be admitted with specific deficiencies which must be made up without degree credit. An applicant with little or no undergraduate training in the field of business administration may enroll as an undergraduate student in business administration for one or more semesters and then be admitted to the Graduate School if his record is satisfactory.

### ACCOUNTING (ACCTG)

401. ADVANCED ACCOUNTING (3)
403. ADVANCED AUDITING (3-9)
404. BUDGETARY CONTROL (3)
405. ADVANCED COST ACCOUNTING (3)
406. ADVANCED FEDERAL TAX ACCOUNTING (3)
407. C.P.A. REVIEW (3)
408. GOVERNMENTAL ACCOUNTING (3)
409. MACHINE AND ELECTRONIC ACCOUNTING METHODS (3)
500. ACCOUNTING SEMINAR (3)
501. ACCOUNTING SYSTEMS (3) Principles of system design including practical application to special businesses, such as financial institutions, department stores, public utilities, etc.
520. PROBLEMS IN ACCOUNTING (3-6) Planned individual projects involving library, laboratory, or field work.



## BUSINESS ADMINISTRATION

### COMMERCE (COM)

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|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| 405. ANALYSIS OF FINANCIAL STATEMENTS (3)                                                                                                                                                                                                  | Mr. Bradley  |
| 406. INVESTMENT ANALYSIS (3)                                                                                                                                                                                                               | Mr. Malott   |
| 408. CASE STUDIES IN BANKING AND FINANCE (3)                                                                                                                                                                                               | Mr. McKinley |
| 415. REGULATION OF TRANSPORT CARRIERS (3)                                                                                                                                                                                                  | Mr. Pashek   |
| 416. PROBLEMS IN TRADE AND TRANSPORTATION (3)                                                                                                                                                                                              | Mr. Waters   |
| 417. FOREIGN MARKETS (3)                                                                                                                                                                                                                   | Mr. Mares    |
| 424. MARKETING RESEARCH (3)                                                                                                                                                                                                                | Mr. Beik     |
| 427. RETAIL BUYING AND MERCHANDISING (3)                                                                                                                                                                                                   | Mr. Beik     |
| 428. RETAIL ADVERTISING AND SALES PROMOTION (3)                                                                                                                                                                                            | Mr. Decker   |
| 430. ADVANCED BUSINESS LAW (3)                                                                                                                                                                                                             | Mr. Phalan   |
| 434. ADVANCED PROPERTY AND CASUALTY INSURANCE (3)                                                                                                                                                                                          | Mr. Lucas    |
| 435. ESTATE PLANNING (3)                                                                                                                                                                                                                   | Mr. Williams |
| 436. FUNDAMENTALS OF SALES MANAGEMENT (3)                                                                                                                                                                                                  | Mr. Decker   |
| 437. CASE STUDIES IN MARKETING (3)                                                                                                                                                                                                         | Mr. Babione  |
| 455. CASES IN PUBLIC RELATIONS (3)                                                                                                                                                                                                         | Mr. Wherry   |
| 477. ADMINISTRATIVE MANAGEMENT (3)                                                                                                                                                                                                         | Mr. Richards |
|                                                                                                                                                                                                                                            |              |
| 500. CASE STUDIES IN BUSINESS ADMINISTRATION (3) Case studies of business and management policy with respect to procurement, production, selling, finance, accounting, relations with government, labor, and the public.                   | Mr. Waters   |
| 501. COMMERCE SEMINAR (3-6) Reports on research in selected fields of commercial activities.                                                                                                                                               | Mr. Waters   |
| 502. SEMINAR IN BUSINESS MANAGEMENT (3-6)                                                                                                                                                                                                  | Mr. Richards |
| 503. TRANSPORTATION AND PUBLIC UTILITY SEMINAR (3-6)                                                                                                                                                                                       | Mr. Cook     |
| 504. PROBLEMS IN COMMERCE (3-6) Planned individual projects involving library, laboratory, or field work.                                                                                                                                  | Mr. Pashek   |
| 506. SEMINAR IN INVESTMENTS AND CORPORATION FINANCE (3-6)                                                                                                                                                                                  | Mr. Bradley  |
| 517. INTERNATIONAL BUSINESS PRACTICES (3) Practices of exporters and importers dealing in commodities traded in world markets under competition, monopoly, or governmental control. Prerequisite: Com. 17.                                 | Mr. Hench    |
| 523. SEMINAR IN MARKETING (3-6) Research in modern marketing trends.                                                                                                                                                                       | Mr. Babione  |
| 525. CASE STUDIES IN INSURANCE (3-6) Analysis of management's insurance problems, such as the feasibility of self-insurance; proper allocation of insurance premiums and coverage in selected industries, etc. Prerequisites: Com. 25, 33. | Mr. Wherry   |
| 536. SALES MANAGEMENT SEMINAR (3) Principles of sales planning and administration; co-ordination of selling with advertising, promotion, production, and accounting; use of market research selling costs and budgets.                     | Mr. Beik     |

## CERAMIC TECHNOLOGY

G. W. BRINDLEY, *Head of the Department*  
214 Mineral Industries Building

The M.S. and Ph.D. degrees are offered in ceramic technology. The background required for admission is a bachelor's degree in ceramics or in one of the related physical sciences. A knowledge of differential and integral calculus is required together with adequate physics and chemistry.

In view of the wide field covered by ceramic technology, the graduate courses may be selected with a bias toward physical ceramics, chemical ceramics, or glass technology. This makes it easily possible for students whose major subject for the bachelor's or master's degree has been either physics or chemistry to take appropriate graduate studies in ceramic technology.

Special facilities exist for research in the areas of clay mineralogy, phase diagram and related studies, ferrite and ferroelectric studies, and glass technology.

## CERAMIC TECHNOLOGY (CER T)

- |                                                                                                                                                                                                                                                    |                                 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| 400. SPECIAL TOPICS (1-2)                                                                                                                                                                                                                          |                                 |
| 401. CERAMIC BODIES AND GLAZES (3)                                                                                                                                                                                                                 | <i>Mr. Hummel</i>               |
| 402. PRINCIPLES OF CERAMIC ENGINEERING (3)                                                                                                                                                                                                         | <i>Mr. McQuarrie</i>            |
| 404. CERAMIC SEMINAR (1)                                                                                                                                                                                                                           |                                 |
| 405. CERAMIC RESEARCH AND DESIGN (3)                                                                                                                                                                                                               | <i>Mr. Hummel</i>               |
| 411. THEORY OF CERAMIC PROCESSES (2)                                                                                                                                                                                                               | <i>Mr. Buessem</i>              |
| 415. GLASS AND ENAMELS (3)                                                                                                                                                                                                                         | <i>Mr. Ehman</i>                |
| 416. ADVANCED GLASS TECHNOLOGY (3)                                                                                                                                                                                                                 | <i>Messrs. Weyl and Rindone</i> |
| 420. REFRACTORIES (3)                                                                                                                                                                                                                              | <i>Mr. McQuarrie</i>            |
| 500. SEMINAR IN CERAMIC TECHNOLOGY (1-2 per semester) Current developments in ceramic technology and related fields. Required of all graduate students in ceramic technology. <i>Mr. Brindley and Staff</i>                                        |                                 |
| 501. COLLOIDAL BEHAVIOR OF CLAYS AND MUDS (2-4) Colloidal properties of ceramic clays, glazes, drilling muds, filtering and bleaching clays, and kindred systems. <i>Mr. Taylor</i>                                                                |                                 |
| 503. USE OF PHASE EQUILIBRIA DATA IN CERAMIC TECHNOLOGY (2-5) Phase equilibria in unary, binary, ternary, and other systems; applications in product development and in understanding behavior of ceramic materials. <i>Mr. Hummel</i>             |                                 |
| 506. MECHANICAL PROPERTIES OF CERAMIC MATERIALS (2-3) Experimental stress-strain-time relations in elasticity, anelasticity, plasticity, and rupture; theory of strength and control. <i>Mr. Buessem</i>                                           |                                 |
| 507. THERMAL PROPERTIES OF CERAMIC MATERIALS (2-3) Heat capacity, heat of fusion, thermal conductivity, and thermal expansion in relation to macroscopic measurements and basic atomic concepts applied to ceramic materials. <i>Mr. McQuarrie</i> |                                 |
| 508. DIELECTRIC AND MAGNETIC PROPERTIES OF CERAMIC MATERIALS (2-3) Preparation and properties of ceramic semi-conductors, dielectrics, and magnetic materials. <i>Mr. Buessem</i>                                                                  |                                 |

## CERAMIC TECHNOLOGY

510. SEMINAR IN GLASS TECHNOLOGY (1-2 per semester) Current developments in glass technology and related fields. *Mr. Weyl and Staff*
511. CHEMICAL ASPECTS OF THE CONSTITUTION OF GLASS (1-3 per semester) Historical development, properties, and atomistic interpretation of changes of properties with compositions, temperature, and past history. *Mr. Weyl*
512. PHYSICAL ASPECTS OF THE CONSTITUTION OF GLASS (1-3) Atomic structure of glass, its relation to physical properties; rheology; glass as a liquid. *Mr. Brindley*
515. SPECIAL PROBLEMS IN CERAMIC TECHNOLOGY (1-6 per semester) Advanced individual study on a problem in ceramics.
516. SELECTED TOPICS IN CERAMIC TECHNOLOGY (1-3 per semester) Intensive group study of special topics.
517. RESEARCH INSTRUMENTS AND EQUIPMENT (2) Applications of fundamental laws and principles in research instruments; care, adjustment, and effective use of instruments and equipment (demonstrations).
530. (Min. 530). STRUCTURE, PROPERTIES, AND OCCURRENCE OF CLAY MINERALS (2-5) Structure analysis and identification of clay minerals; mineral transformation and behavior; occurrence, genesis, and petrography of fine-grained sediments. *Messrs. Brindley, Bates, and Griffiths*

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in ceramic technology studies are listed under Mineral Sciences in Part II of this bulletin. The subject of color in glasses is treated in Min. 521.

## CHEMICAL ENGINEERING

W. CONARD FERNELIUS, *Head of the Department*  
102 Walker Laboratory

Graduate work in this department leads to the M.S. or Ph.D. degrees. The minimum undergraduate requirements for admission are 24 semester hours of chemical engineering including stoichiometry, industrial chemistry, unit operations, thermodynamics, plant design, kinetics, or chemical engineering problems; 14 semester hours of engineering including engineering mechanics, electrical engineering, or mechanical engineering basic courses; chemistry through one year of physical chemistry; and mathematics through differential equations.

### CHEMICAL ENGINEERING (CH E)

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|------------------------------------------------------|---------------------|
| 402. CHEMICAL ENGINEERING (4)                        | <i>Mr. Carnahan</i> |
| 403. CHEMICAL ENGINEERING (4)                        | <i>Mr. Carnahan</i> |
| 404. CHEMICAL PLANT DESIGN (3)                       | <i>Mr. Williams</i> |
| 405. THERMODYNAMICS FOR CHEMICAL ENGINEERS (3)       | <i>Mr. Cannon</i>   |
| 406. CHEMICAL ENGINEERING PROBLEMS (3)               | <i>Mr. Williams</i> |
| 420. CRYOGENIC ENGINEERING (3)                       | <i>Mr. Fritz</i>    |
| 422. MOTOR FUELS (2)                                 | <i>Mr. Carnahan</i> |
| 430. CHEMICAL TECHNOLOGY IN THE NUCLEAR INDUSTRY (3) | <i>Mr. Lloyd</i>    |



## CHEMICAL ENGINEERING

500. SEMINAR IN CHEMICAL ENGINEERING (1) Required of all graduate students.
510. ADVANCED HEAT TRANSFER I (3) Physical and chemical factors controlling the rate of heat transfer under conditions of steady flow.
511. ADVANCED HEAT TRANSFER II (3) Flow of heat under varying temperature conditions.
515. DISTILLATION (3) Commercial distillation, equilibrium diagrams, vapor composition, stills and rectifying and stripping columns. *Mr. Carnahan*
516. ECONOMIC BALANCE (3) Problem work on the design of chemical engineering equipment from the economic standpoint. *Mr. Cannon*
518. CHEMICAL ENGINEERING DESIGN (3) Complicated examples are discussed and worked out. Several different unit operations will be combined for the design of a complete installation.
520. EXTRACTION PROCESSES (3) Equilibrium extraction data and phase contacting and settling related to equipment design.
521. MASS TRANSFER (3-12) Problem course on developments in diffusion, fluid dynamics, phase equilibrium, process kinetics, and control; use of digital and analog computers. *Mr. Rose*
524. CHEMICAL ENGINEERING, APPLICATION OF THERMODYNAMICS (3) Elements of thermochemistry and thermodynamics of greatest importance in chemical engineering. *Mr. Cannon*
530. HEAT TRANSFER IN NUCLEAR REACTORS (3) Fluid flow, heat transfer, and design problems in nuclear reactor systems. *Mr. Lloyd*

## CHEMISTRY

W. CONARD FERNELIUS, *Head of the Department*  
212 Whitmore Laboratory

The department offers graduate work leading to the M.Ed., M.S., D.Ed., and Ph.D. degrees. Students may specialize in analytical, inorganic, organic, physical, and petroleum chemistry. The general facilities for instruction and research in the major fields of chemistry are excellent, while the cryogenic, microscopy, petroleum, radiochemical, and spectroscopy laboratories provide a number of unusual features.

Entering graduate students should have had training which includes at least one year's work in each of the following: general chemistry, analytical chemistry, organic chemistry, physical chemistry, and general physics. Mathematics through integral calculus is required, and a reading knowledge of at least one foreign language, preferably German, is expected.

Prior to scheduling their first semester's program, new students will take examinations in the four areas of analytical, inorganic, organic, and physical chemistry. The information obtained from these tests will assist both the student and his adviser in making up a program best suited to the entering student's needs. These examinations are normally given just prior to the regular registration period.

# CHEMISTRY

## CHEMISTRY (CHEM)

400. CHEMICAL LITERATURE (1) *Mrs. Strauss*
401. SEMINAR (1)
405. NUCLEAR AND RADIOCHEMISTRY (3) Breakage ticket \$5.  
*Messrs. Currie and Miller*
410. ADVANCED INORGANIC CHEMISTRY (4) Breakage ticket \$5.
413. INORGANIC PREPARATIONS AND LABORATORY METHODS (2-5) Breakage ticket \$5.
420. ADVANCED ANALYTICAL CHEMISTRY (4) Breakage ticket \$10.  
*Messrs. Hayes, Jordan, and Schempf*
426. INSTRUMENTAL METHODS OF ANALYSIS (3-5) Breakage ticket \$10.  
*Messrs. Hayes, Jordan, and Schempf*
435. ORGANIC PREPARATIONS AND LABORATORY METHODS (3-5) Breakage ticket \$10.  
*Mr. Oakwood*
437. QUALITATIVE ORGANIC ANALYSIS (3) Breakage ticket \$5.  
*Messrs. Oakwood and Noll*
440. ADVANCED PHYSICAL CHEMISTRY (3) *Messrs. Hutchison and Seward*
441. ADVANCED PHYSICAL CHEMISTRY (2) *Messrs. Fritz and Taft*
448. COLLOID CHEMISTRY (3) Breakage ticket \$5. *Mr. Benson*
- \*460-461. INTRODUCTORY PHYSICAL CHEMISTRY (3 each)
- \*462. EXPERIMENTAL PHYSICAL CHEMISTRY (1) Breakage ticket \$5.
- \*463. EXPERIMENTAL PHYSICAL CHEMISTRY (1) Breakage ticket \$5.
- \*464-465. PHYSICAL CHEMISTRY (3 each)
470. CHEMICAL MICROSCOPY (3) Breakage ticket \$5. *Miss Willard*
471. ADVANCED CHEMICAL MICROSCOPY (3) Breakage ticket \$5. *Miss Willard*
472. QUANTITATIVE ORGANIC MICROANALYSIS (3) Breakage ticket \$5. *Mr. Fleming*
473. TEXTILE MICROSCOPY (3) Breakage ticket \$5. *Miss Willard*
474. QUANTITATIVE ORGANIC MICROANALYSIS (3) Breakage ticket \$5. *Mr. Fleming*
476. MICROSCOPIC MICROTECHNIQUE (3) Breakage ticket \$5. *Miss Willard*
477. CHEMICAL PHOTOMICROGRAPHY (3) Breakage ticket \$5. *Miss Willard*
489. INTRODUCTION TO CHEMICAL RESEARCH (3-5) Breakage ticket \$10.
- †490. ORGANIC CHEMISTRY (5) Breakage ticket \$5.
- †491. ORGANIC CHEMISTRY (5) Breakage ticket \$10.
- 492a. ADVANCED GENERAL CHEMISTRY FOR TEACHERS (3)
493. SELECTED TOPICS IN CHEMISTRY FOR TEACHERS (3)
494. CHEMICAL DEMONSTRATIONS FOR TEACHERS (3)
500. SEMINAR IN INORGANIC CHEMISTRY (1 per semester)
501. SEMINAR IN PHYSICAL CHEMISTRY (1 per semester)
502. SEMINAR IN ORGANIC CHEMISTRY (1 per semester)
503. SEMINAR IN ANALYTICAL CHEMISTRY (1 per semester)
516. SYSTEMATIC INORGANIC CHEMISTRY (3) Systematic treatment of inorganic chemistry in terms of modern concepts. *Messrs. Fernelius, Wartik, and Haas*
517. CHEMISTRY OF THE LESS FAMILIAR ELEMENTS (3) Continuation of Chem. 516.  
*Messrs. Fernelius, Wartik, and Haas*

\* Graduate credit not allowed for students majoring in chemistry or chemical engineering.

† Candidates for the M.Ed. degree.

518. SPECIAL TOPICS IN INORGANIC CHEMISTRY (3 per semester) Modern developments in specialized fields.
525. ANALYTICAL PROCESSES (3) Separative and determinative processes in analytical chemistry. *Messrs. Hayes, Jordan, and Schempf*
526. MODERN INSTRUMENTAL ANALYSIS (3) *Messrs. Hayes, Jordan, and Schempf*
527. SPECIAL TOPICS IN ANALYTICAL CHEMISTRY (2-12) *Messrs. Hayes, Jordan, and Schempf*
531. SPECIAL TOPICS IN ORGANIC CHEMISTRY (3-12)
532. ORGANIC NITROGEN COMPOUNDS (3) Chemistry, stereochemistry, and molecular structure of organic compounds containing nitrogen. *Mr. Aston*
534. THEORETICAL ORGANIC CHEMISTRY (3) Modern theories of structure; resonance; interpretation of physical properties; theory of rates; equilibrium properties. *Mr. Aston*
- 535-536. ORGANIC CHEMISTRY (3 each) Adapted to the needs of those doing research work in organic chemistry. *Mr. Zook*
537. ORGANIC CHEMISTRY OF HIGH POLYMERS (3) High polymer theory and practice from the viewpoint of organic chemistry. *Mr. Sommer*
538. ORGANIC CHEMISTRY (3) Survey of organic chemistry arranged primarily for graduate students majoring in fields other than organic chemistry. *Messrs. Noll and Oakwood*
539. STEREOCHEMISTRY (3) Comprehensive treatment of the principles of stereochemistry as applied to organic compounds. *Mr. Oakwood*
540. EXPERIMENTAL METHODS OF PHYSICAL CHEMISTRY (3-5)
541. PHASE RULE (3) The phase rule and its applications.
542. COLLOIDS (3) The physics and chemistry of surfaces and their resulting colloid properties; methods of preparing colloids. *Mr. Smith*
544. CHEMICAL THERMODYNAMICS (3) Development of thermodynamic theory with special reference to common physical changes and chemical reactions. Prerequisite: Chem. 461. *Messrs. Aston and Fritz*
545. CHEMICAL THERMODYNAMICS AND INTRODUCTORY STATISTICAL MECHANICS (3) Continuation of Chem. 544 including the calculation of thermodynamic properties from molecular and spectroscopic data. Prerequisite: Chem. 544. *Messrs. Aston and Fritz*
546. QUANTUM CHEMISTRY (3) Calculation of electronic properties of atoms and molecules by wave mechanical methods including molecular orbital theory. Prerequisite: Chem. 565. *Messrs. Aston and Goodman*
547. STATISTICAL MECHANICS (3) Properties of matter at equilibrium, developed on the basis of energy levels of molecules and statistical mechanical theory. Prerequisite: Chem. 565. *Mr. Aston*
548. CATALYSIS (3) Theory of catalysis and its application to industry.



## CHEMISTRY

549. PHYSICAL CHEMISTRY OF HIGH POLYMERS (3) Physicochemical principles related to the properties of synthetic and natural polymeric systems. *Mr. Woodward*
560. TOPICS IN PHYSICAL CHEMISTRY (3-12)
- 561-562. CHEMICAL PRINCIPLES (3 each) Mathematical treatment of the classical principles of chemistry; their application to problems. Required of all graduate students. Prerequisites: Chem. 461, Math. 43, Phys. 285. A course in organic chemistry is recommended.
563. CHEMICAL KINETICS (3) Theory and measurement of the rates of chemical reactions; the mechanism of chemical reactions. *Messrs. Ascah and Taft*
564. CHEMICAL KINETICS (3) Continuation of Chem. 563 but including theory and measurement of photochemical reactions. *Messrs. Ascah and Taft*
565. ATOMIC AND MOLECULAR STRUCTURE (3) Introduction to modern theoretical chemistry: chemical bonds and molecular spectra.
567. ADVANCED THEORETICAL CHEMISTRY (3) Modern and current theories of the properties of chemical substances and their applications to chemical problems; the construction of chemical theory.
581. EXPERIMENTAL METHODS IN PETROLEUM CHEMISTRY (1-12)
582. TOPICS IN PETROLEUM CHEMISTRY (2-6)

## CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS

WINONA L. MORGAN, *Head of the Department*  
19A Home Economics Building

The M.S. and M.Ed. degrees are offered in the general field of child development and family relationships. The Ph.D. and D.Ed. degrees are offered in either child development or family relationships.

Students may specialize in the guidance and development of children, relationships among various members of the family, problems of all stages of the family cycle, nursery school education, education for home and family living in the schools, parental education, and work with children and families in community agencies.

The entering student should have had at least 6 credits in the physical and biological sciences, 12 in the social sciences (which must include a basic course in sociology and one in psychology), and 6 in child development and family relationships. Students who are otherwise qualified but who lack some of these credits may be admitted and permitted to make up the deficiency credits along with a graduate program.

### CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS (CD FR)

405. MARRIAGE AND FAMILY RELATIONSHIPS (3) *Mr. Smith*
429. CHILD DEVELOPMENT (3) *Miss Avery*

## CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS

430. OBSERVATION AND EXPERIENCE IN NURSERY SCHOOL (1-4)  
440. STUDY OF LATER CHILDHOOD (3) *Miss Avery*  
441. NURSERY SCHOOL ORGANIZATION (3) *Miss Morgan*  
445. (Psy. 445). DEVELOPMENT THROUGHOUT ADULTHOOD (3) *Mr. Smith*  
481. EDUCATIONAL METHODS WITH PRESCHOOL CHILDREN (3) *Miss Russell*  
482. EDUCATIONAL PROCEDURES IN CHILD DEVELOPMENT AND FAMILY RELATIONS (3) *Miss Morgan*
508. PARENTAL EDUCATION (3) Discussion and use of methods, experiences, and programs which can be used effectively to help parents in dealing with problems of parent-child relationships. Prerequisites: C.D.F.R. 429, 430. *Miss Morgan*
515. THE TEACHING OF CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS (3) Methods of selection and presentation of subject matter basic to understanding the development of children, and the attitudes, emotions, and relationships within the family. Not open to students having credit for C.D.F.R. 482. Prerequisite: 6 credits in child development and family relationships. *Miss Morgan*
529. (Psy. 529). SEMINAR IN CHILD DEVELOPMENT (1-6) Readings and reports on recent findings in child development. Prerequisites: 6 credits in child development or 6 in educational or child psychology, plus 3 in statistics.
530. PROBLEMS IN CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS (1-6) Problems involving individual research in library, laboratory, or field projects.
536. CHILDREN IN POSTWAR FAMILIES AND COMMUNITIES (3) Postwar family and community situations influencing the development of children; the role of parents and teachers in helping individual children make satisfactory adjustments. Prerequisites: C.D.F.R. 429, 430, or 2 courses in psychology. *Miss Morgan*
545. THE FAMILY IN ITS COMMUNITY (2-3) Cultural influences on family relationships; how the family orients its members to community living and group participation. Prerequisites: Soc. 1, C.D.F.R. 405; R.Soc. 452 or Psy. 419. *Mr. Smith*
546. SEMINAR IN FAMILY RELATIONSHIPS (1-3) Reading, reports, and discussion of recent research in relationship aspects of family living; particular attention to studies of roles, crises, and adjustments within the family setting. Prerequisite: C.D.F.R. 405 or 6 credits in sociology or psychology. *Mr. Smith*

## CIVIL ENGINEERING

BENJAMIN A. WHISLER, *Head of the Department*  
208 Sackett Building

Graduate work leading to the M.S., M.Eng., and Ph.D. degrees is offered. The entering student should be a graduate in civil engineering from an accredited college of engineering. Students may specialize in structures, hydraulics, transportation engineering, surveying, and sanitary engineering, or combinations of these, through courses offered both by the Department of Civil Engineering and by other departments of the University.

## CIVIL ENGINEERING

### CIVIL ENGINEERING (C E)

- 400. SEMINAR (1-3)
- 401. CIVIL ENGINEERING PROJECTS (2-12)
- 412. ADVANCED PHOTOGRAMMETRY (3)
- 421. HIGHWAYS AND STREETS (3)
- 423. HIGHWAY SAFETY AND TRAFFIC CONTROL (3)
- 431. CIVIL ENGINEERING CONSTRUCTION (3)
- 441. STATICALLY INDETERMINATE STRUCTURES (3)
- 442. STATICALLY INDETERMINATE STRUCTURES (3)
- 446. ADVANCED SOIL MECHANICS (3)
- 451. ADVANCED HYDROLOGY (3)
- 462. ADVANCED HYDRAULICS (3)
- 465. ELEMENTS OF HYDRAULIC ENGINEERING (3)
- 466. HYDRAULIC MACHINERY (3)
- 471. MUNICIPAL AND RURAL SANITATION (3)
- 472. TREATMENT PLANTS (4)
- 473. WATER AND SEWAGE ANALYSIS (3)
- 474. SANITARY ENGINEERING PROBLEMS (1-6)
  
- 500. SEMINAR IN CIVIL ENGINEERING (1-6) Reports on researches and special topics. Course may be continued in subsequent semesters.
  
- 521. TRANSPORT PLANNING AND DESIGN (2-6) Planning and design of transportation facilities; basic principles and engineering techniques applied to airways, highways, pipe lines, railways, waterways. Prerequisite or concurrent: C.E. 51 or 421.
  
- 522. TRANSPORT OPERATION AND MAINTENANCE (2-6) Engineering problems in operation, maintenance, and administration of airways, highways, pipe lines, railways, waterways. Prerequisite or concurrent: C.E. 51 or 421.
  
- 540. ADVANCED STRUCTURAL ANALYSIS (2-4) Geometry of flexure, deflections; analysis of continuous beams, rigid frames, arches; influence lines. Prerequisite: C.E. 40.
  
- 541. ADVANCED STRUCTURAL ANALYSIS (2-4) Truss deflection; trusses with redundant members, continuous trusses, framed arches; influence lines; secondary stresses; wind stresses; space framework; suspension bridges. Prerequisite: C.E. 40.
  
- 542. APPLIED SOIL MECHANICS (2-5) Soil classification by type of clay minerals and profile development; aerial photographic interpretation of soils and applications to site selection for dams, highways, and airports. Prerequisites: C.E. 412, 444, Geol. 71.
  
- 543. STRUCTURAL ENGINEERING PROJECTS (3-10) Investigation or design projects in concrete, soil mechanics, photoelasticity, analysis, etc. Prerequisite or concurrent: C.E. 441, 442.
  
- 544. ADVANCED STRUCTURAL DESIGN (2-4) Plain and reinforced concrete design as applied to buildings, bridges, retaining walls, domes, tanks, and dams; pre-stressed concrete. Prerequisites: C.E. 42, 442.
  
- 545. ADVANCED STRUCTURAL DESIGN (2-4) Structural steel design as applied to riveted and welded girders, trusses, rigid frames, wind connections; timber design. Prerequisite: C.E. 41.



547. **ADVANCED STRUCTURAL THEORY (3-6)** Prestressed concrete, arches, suspension bridges, concrete dams, thin shells, and other current topics. Prerequisites: C.E. 441, 442.
550. **ENGINEERING CONSTRUCTION (2-4)** Construction methods applied to foundations, buildings, bridges, and other civil engineering construction work. Prerequisites: C.E. 41, 42.
551. **HYDROLOGIC INVESTIGATIONS (2-8)** Application of hydrologic principles and techniques to a specific project. Prerequisite: C.E. 451.
560. **THEORY OF HYDRAULIC MODELS (3)** Application of dimensional analysis and similitude to models used in the study of problems in hydraulics.
564. **HYDRAULIC ENGINEERING DESIGN (2-8)** Design and analysis of selected units of a typical hydraulic engineering project.
565. **TRANSPORTATION OF SOLIDS BY FLUIDS (2-5)** Fundamentals of the flow of solids in open and closed conduits; e.g., suspended load and bed load in rivers, slurries and pulp stocks in pipes.
566. **FLUID MECHANICS OF HYDRAULIC MACHINERY (3)** Advanced theory and design of hydraulic machinery. Prerequisite: C.E. 466.
570. **RURAL SANITATION DESIGN (3)** Requirements and devices essential to rural sanitary problems: water supply, excreta disposal, industrial waste treatment. Not intended for civil or sanitary engineering students. Prerequisites: Chem. 4, Phys. 285.
571. **WATER PURIFICATION AND SOFTENING (3)** Current methods of softening, disinfecting, and conditioning water for municipal and industrial use. Prerequisite: C.E. 70.
572. **SEWAGE TREATMENT (3)** Modern methods of sewage treatment. Prerequisite: C.E. 70.
573. **ADVANCED PROBLEMS IN SANITARY ENGINEERING (3-10)** Continuation of C.E. 474 on a graduate level. Prerequisite: C.E. 474.
575. **ADVANCED INDUSTRIAL WASTE TREATMENT (3)** Techniques of industrial waste treatment; attendant stream pollution and stream self-purification factors. Prerequisite: C.E. 472 or 572.
576. **WATER TREATMENT PLANT DESIGN (1-6)** Design of works for treatment of water for municipal and industrial use. Prerequisite: C.E. 71.
577. **SEWAGE TREATMENT PLANT DESIGN (1-6)** Design of works for treatment of sewage or industrial wastes. Prerequisite: C.E. 71.
578. **INDUSTRIAL HYGIENE (3)** Principles of control of industrial toxics and the protection of the worker and the community.
579. **PUBLIC HEALTH ADMINISTRATION (3)** Operation and duties of health departments at the various levels.

## CLINICAL SPEECH

EUGENE T. McDONALD, *Director of the Speech and Hearing Clinic*  
2S Sparks Building

The Speech and Hearing Clinic offers graduate training leading to the M.Ed., M.S., D.Ed., and Ph.D. degrees. Students may specialize in either speech correction or audiology.

Admission to study for either master's degree requires 27 semester hours in clinical speech and hearing, education, and psychology courses. These must include at least 9 credits in speech correction and/or audiology. Applicants for the M.Ed. degree must have had student teaching. Applicants for the M.S. degree may count credits in speech science toward the required 27 hours.

## SPEECH EDUCATION (SP ED)

- 430. HEARING PROBLEMS AND THE TESTING OF HEARING (3)
- 434. AUDIOMETRY AND HEARING AIDS (3)
- 435. CLINICAL PRACTICE WITH THE HEARING HANDICAPPED (1-6)
  - Unit A. Audiologic Evaluation and the Selection of Hearing Aids (1-4)*
  - Unit B. Auditory Training and Speech Reading (1-4)*
- 436. INTRODUCTION TO SPEECH CORRECTION (3)
- 437. CLINICAL PRACTICE IN SPEECH CORRECTION (1-3)
- 440. SPEECH EDUCATION FOR THE CLASSROOM TEACHER (2-3)
- 441. CURRENT PROBLEMS IN SPEECH AND HEARING (1-6)
- 442. SPEECH PATHOLOGY (3)
- 443. METHODS IN AUDITORY TRAINING AND SPEECH READING (3)
- 445. THE PUBLIC SCHOOL SPEECH CORRECTION PROGRAM (3)
  
- 525. SEMINAR IN CLINICAL SPEECH PATHOLOGY (3-9) Prerequisites: Sp.Ed. 436, 442.
  - Unit A. Cleft Palate*
  - Unit B. Cerebral Palsy*
  - Unit C. Aphasia*
  
- 530. SEMINAR IN AUDIOLOGY (2-4) Review of theories of hearing and review of related physiological and psychological researches. Prerequisite: Sp.Ed. 434.
  
- 537. ADVANCED CLINICAL PRACTICE IN SPEECH CORRECTION (1-9) Prerequisites: Sp.Ed. 437, 442.
  - Unit A. Diagnostic Procedures (1-3)*
  - Unit B. Treatment Procedures (1-6)*
  
- 540. ARTICULATION DISABILITIES (3) Speech-sound production disorders in children and adults; methods of examination, diagnosis, and treatment. Prerequisites: Sp.Ed. 437, 442.
  
- 541. THE VOICE AND ITS DISORDERS (3) Physical, physiological, and psychological bases of voice production; causes, nature, and symptoms of its disorders; current clinical methods in voice improvement. Prerequisites: Sp.Ed. 437, 442.
  
- 542. STUTTERING AND ALLIED DISORDERS (3) Modern theories of causes of disorders of rhythm; methods of examination, diagnosis, and treatment. Prerequisites: Sp.Ed. 437, 442.

543. **DIAGNOSTIC PROCEDURES IN CLINICAL SPEECH** (3) Clinical instrumentation; case history taking; examination procedures and materials used in diagnosing speech disabilities; interpretation of findings; report preparation. Prerequisites: Sp.Ed. 437, 442.

## CLOTHING AND TEXTILES

RUTH W. AYRES, *Head of the Department*  
116A Home Economics Building

A graduate major in clothing and textiles may lead to an M.S., M.Ed., Ph.D., or D.Ed. degree. Work may be taken with major emphasis on the textile side, which stresses the background natural sciences, or on the clothing side, which stresses the background social sciences. Candidates are accepted who have a strong background and a good record in home economics, chemistry, sociology, economics, or psychology.

### CLOTHING AND TEXTILES (CL TX)

402. **FUNDAMENTAL PRINCIPLES OF TAILORING CONSTRUCTION** (3)  
 403. **CREATIVE PATTERN MAKING** (3)  
 404. **DRAPING** (3)  
 406. **FASHION PROMOTION** (3)  
 407. **THE TEXTILE AND CLOTHING INDUSTRY** (3)  
 408. **INTERMEDIATE TEXTILES** (3)  
 410. **CLOTHING FOR THE FAMILY** (3)  
 411. **ADVANCED CLOTHING CONSTRUCTION** (3)  
 413. **TEXTILE TECHNOLOGY** (3)
503. **ADVANCED PATTERN DEVELOPMENT** (3) Analysis of advanced pattern designing principles to give students facility in original designing.
504. **ADVANCED DRAPING** (3) Analysis of principles and techniques as a basis for creation of original designs; survey of literature in dress design.
505. **CLOTHING INSTRUCTIONAL MATERIALS** (3) Development of instructional materials and techniques based on needs of diverse groups.
506. **THE FASHION WORLD** (3)
507. **PROBLEMS IN RELATION TO CLOTHING CONSUMPTION** (3) Problems connected with manufacture and consumption of clothing; interrelation of textile and clothing trades with other industries.
508. **SPECIAL PROBLEMS IN CLOTHING AND TEXTILES** (1-6) Individual directed study, investigation, and practice in selected phases of textiles and clothing.
509. **SEMINAR IN CLOTHING AND TEXTILES** (1-6)
510. **RESEARCH METHODS AND EVALUATION IN CLOTHING AND TEXTILES** (1-6)
511. **CURRENT DEVELOPMENTS IN CLOTHING AND TEXTILES** (1-6)
512. **HISTORY OF CLOTHING AND CLOTHING CONSTRUCTION** (3)
513. **ADVANCED TEXTILE TECHNOLOGY** (6)



## COMPARATIVE LITERATURE

PHILIP A. SHELLEY

*Chairman of the Committee on Comparative Literature*  
229 Sparks Building

Graduate study in comparative literature may lead to the M.A. and Ph.D. degrees. Programs are arranged through a meaningful selection of courses offered by the several departments of languages and literatures, both ancient and modern, as well as of those specifically in the category of comparative literature. More than a minimum knowledge of foreign languages is required.

### COMPARATIVE LITERATURE (C LIT)

- 400. COMPARATIVE METHOD IN LITERARY STUDIES (3)
- 443. (Ger. 443). LITERARY RELATIONS OF GERMANY WITH ENGLAND AND AMERICA (3-9) *Mr. Shelley*
- 480. INTRODUCTION TO FOLKLORE (3) *Mr. Bayard*
- 500. SEMINAR IN COMPARATIVE LITERATURE (3-6)

## DAIRY SCIENCE

DONALD V. JOSEPHSON, *Head of the Department*  
105 Dairy Building

Graduate programs lead to the M.S. and Ph.D. degrees with specialization in dairy products manufacture, chemistry of milk and dairy products, dairy cattle nutrition, dairy cattle management, and physiology of reproduction. The minor program is generally taken in agricultural and biological chemistry, bacteriology, zoology, or agricultural economics.

Prerequisite to graduate work is the completion of an undergraduate curriculum in dairy science or a related science area. The undergraduate program must include college algebra and general physics. Students may be admitted with limited deficiency but are required to make up undergraduate deficiency work without degree credit.

### DAIRY SCIENCE (D SC)

- 418. DAIRY SURVEY (1) *Mr. Josephson*
- 421. DAIRY MANUFACTURING PROBLEMS (1-6) *Mr. Doan and Staff*
- 427. MILK SECRETION (3) *Mr. Kesler*
- 428. DAIRY PRODUCTION PROBLEMS (1-3) *Mr. Kesler and Staff*
- 430. TECHNICAL CONTROL OF DAIRY PRODUCTS (4) *Mr. Watrous*
- 431. PHYSIOLOGY OF REPRODUCTION IN FARM ANIMALS (3) *Mr. Almquist*
- 501. BUTTER AND CHEESE (1-6) Manufacture and handling of butter and cheese.  
Prerequisites: D.Sc. 10, 23, Bact. 8, A.B.Ch. 403.
- 502. CONDENSED MILK AND MILK POWDER (1-6) Condensing and drying of milk.  
Prerequisites: D.Sc. 10, 26, Bact. 8, A.B.Ch. 403. *Mr. Doan*
- 503. PUBLIC MILK PROBLEMS (1-6) Handling milk in modern plants. Prerequisites: D.Sc. 11, Bact. 8, A.B.Ch. 403. *Mr. Doan*

504. ICE CREAM MANUFACTURE (1-6) Manufacture of ice cream, ices, and other frozen milk products. Prerequisites: D.Sc. 11, Bact. 8, A.B.Ch. 403. *Mr. Keeney*
505. DAIRY PLANT ECONOMICS (1-6) Economic factors involved in creamery operation and management. Prerequisites: D.Sc. 7, 11. *Mr. Watrous*
507. DAIRY CATTLE MANAGEMENT (1-6) Management of dairy cattle. Prerequisite: D.Sc. 27. *Mr. Williams and Staff*
508. DAIRY SEMINAR (1-6) Preparation and presentation of a paper on an assigned subject.
509. TESTING DAIRY PRODUCTS (1-6) Constituents of dairy products. Prerequisites: D.Sc. 11, Bact. 8, A.B.Ch. 403. *Mr. Doan*
510. DAIRY CATTLE FEEDING (1-6) Application of fundamental research in animal nutrition to the feeding of dairy cattle. Prerequisites: D.Sc. 1, 29. *Mr. Williams*
511. DAIRY CATTLE NUTRITION (1-6) Nutritional requirements of dairy cattle. Prerequisites: A.Ntr. 401, 402. *Mr. Kesler*
512. ADVANCED STUDIES IN MILK SECRETION (1-6) Physiology of milk secretion. Prerequisite: D.Sc. 427. *Mr. Kesler*
513. DAIRY CATTLE SELECTION (1-6) Breed history, pedigrees, selection and judging of dairy cattle. Prerequisites: D.Sc. 1, 30.
515. ADVANCED PHYSIOLOGY OF REPRODUCTION IN FARM ANIMALS (1-6) *Mr. Almquist*
516. ARTIFICIAL BREEDING OF FARM ANIMALS (1-6) Prerequisite: D.Sc. 431. *Mr. Almquist*
517. DAIRY SCIENCE LITERATURE (1-6) Review and reporting of dairy literature. *Mr. Josephson and Staff*
522. RESEARCH PROCEDURES IN DAIRY TECHNOLOGY (3) Research problems and methods in dairy technology with major emphasis on dairy chemistry. Prerequisite: A.B.Ch. 403. *Mr. Patton*

## ECONOMICS

MONROE NEWMAN, *Head of the Department*  
124 Boucke Building

Graduate work leading to the M.A. and Ph.D. degrees is offered. Opportunities are available for concentration in business statistics, economic theory, labor, international economics, government economic policy, money, credit, and public finance.

To enter graduate work in economics a student should have completed 6 credits in economic principles, 9 in the social sciences, and either 3 in statistics or 6 in mathematics.

### BUSINESS STATISTICS (B S)

500. SEMINAR IN BUSINESS STATISTICS (3) *Mr. Saylor*
501. ADVANCED BUSINESS STATISTICS (3) *Mr. Saylor*

## ECONOMICS

### ECONOMICS (ECON)

400. HISTORY OF ECONOMIC THOUGHT (3)  
404. ECONOMIC FRAMEWORK OF MODERN SOCIETY (3)  
405. INTERMEDIATE ECONOMIC THEORY (3)  
406. ECONOMIC GROWTH AND DEVELOPMENT (3)  
412. ECONOMICS OF COLLECTIVE BARGAINING (3) *Mr. Myers*  
415. SOCIAL INSURANCE (3) *Mr. Reede*  
418. ECONOMICS OF WAGES AND EMPLOYMENT (3) *Mr. Newman*  
419. CASE STUDIES IN LABOR-MANAGEMENT RELATIONS (3) *Mr. Reede*  
423. STATE AND LOCAL TAXATION (3) *Mr. Stout*  
425. THE MONEY MARKET (3)  
428. INCOME AND EMPLOYMENT THEORY (3) *Mr. Kautz*  
429. FEDERAL FINANCES (3)  
433. INTERNATIONAL MONETARY ECONOMICS (3) *Mr. Mason*  
434. INTERNATIONAL TRADE AND PUBLIC POLICY (3) *Mr. Mares*  
442. MONOPOLY, COMPETITION, AND THEIR REGULATION (3)  
450. THE BUSINESS CYCLE (3)  
480. MATHEMATICAL ECONOMICS (3)  
490. MEASUREMENT OF THE ECONOMY (3)  
499. FOREIGN STUDY IN ECONOMICS (2-6)  
500. ECONOMICS SEMINAR (3-6)  
501. RESEARCH METHODS IN ECONOMICS (3-6) Fall semester.  
506. PROBLEMS IN ECONOMICS (3-6) Planned individual projects involving library, laboratory, or field work.  
507. SEMINAR IN INTERNATIONAL ECONOMICS: THEORY AND POLICY (3-6) Spring semester, even years.  
508. SEMINAR IN MONEY, CREDIT, AND PUBLIC FINANCE (3-6) Prerequisite: Econ. 51. Spring semester, odd years.  
510. ECONOMETRICS (3) Statistical estimation in mathematically formulated economic relationships. Spring semester, even years.  
511. SEMINAR IN INDUSTRIAL DISPUTES (3) Prerequisites: Econ. 14, 15. Fall semester, even years. *Mr. Myers*  
512. WAGES (3) Fall semester, odd years. *Mr. Newman*  
513. DEVELOPMENT OF ECONOMIC DOCTRINES (3-6) Prerequisite: Econ. 405. Spring semester. *Mr. Martin*  
515. LABOR SEMINAR (3) Spring semester. *Mr. Reede*  
522. ADVANCED ECONOMIC THEORY (3-6) Theory of price and income determination. Prerequisite: Econ. 405. Fall semester, micro; spring semester, macro.

## EDUCATION

CHARLES M. LONG, *Head of the Department*  
109 Burrowes Building

Graduate degree programs in the department are provided for the advanced preparation of competent public school teachers, administrators, supervisors, and special-



ists. Candidates for the M.Ed., M.S., D.Ed., and Ph.D. degrees may major in business education, counseling in education, educational administration, elementary education, higher education (D.Ed. program only), clinical speech, and secondary education.

In general, admission requirements for the M.Ed. include 27 approved undergraduate credits in education and psychology including practice teaching in an area appropriate to the major, and aptitude for and interest in advanced professional preparation. Applicants are encouraged to have had at least two years of successful teaching experience. The admission requirements for the M.S. and Ph.D. degrees, and the D.Ed. degree in higher education, are slightly different.

Course sequences are also provided in audio-visual instruction, language arts education, history and philosophy of education, special education, educational research, curriculum and supervision, nature education, adult education, and safety education.

While candidates are required to specialize in a field of professional education, they are also encouraged to acquire a general education in the social sciences, the behavioral sciences, and the humanistic foundations.

In addition to these programs sponsored by the Department of Education, other departments offer work in agricultural education, art education, home economics education, industrial education, music education, physical education, and recreation education. Programs in these major fields are described elsewhere in this bulletin.

The M.Ed. degree is, in general, available in those fields outside of education for which a master's degree has been approved, provided such a professional program is appropriate. Thus, for example, the M.Ed. degree may be earned with a major in English or chemistry. These programs require an approved minor in education.

## EDUCATION (ED)

- 408. INTRODUCTION TO VOCATIONAL REHABILITATION (3)
- 409. MEDICAL INFORMATION FOR COUNSELORS (3)
- 412. HISTORY OF MODERN EUROPEAN EDUCATION (3)
- 413. HISTORY OF EDUCATION IN THE UNITED STATES (2-3)
- 415. MODERN TENDENCIES IN AMERICAN EDUCATION (1-6)
- 424. VISUAL AND OTHER SENSORY AIDS FOR TEACHERS (1-3)
- 425. THE SCIENTIFIC DIRECTION OF LEARNING ACTIVITIES (2-4)
- 426. EDUCATION OF EXCEPTIONAL CHILDREN (2-3)
- 427. EDUCATION OF THE MENTALLY RETARDED (2-3)
- 428. ADULT EDUCATION: ORGANIZATION, TYPES, AND METHODS (1 per unit)
  - Unit A. History, Philosophy, and General Organization and Administration of Adult Education (1)*
  - Unit B. Types of Adult Education: Parental Education (1)*
  - Unit C. Methods in Adult Education and Leadership of Discussion Groups (1)*
- 429. EDUCATION OF THE MENTALLY GIFTED CHILD (1-3)
- 430. VISUAL AND OTHER AIDS IN SAFETY EDUCATION (3)
- 432b. THE ELEMENTARY SCHOOL READING PROGRAM (2-3)
- 432c. READING PROBLEMS IN THE SECONDARY SCHOOL (2-3)
- 432d. SPECIAL PROBLEMS IN THE TEACHING OF ELEMENTARY SCHOOL ENGLISH (2-3)
- 432f. TEACHING SECONDARY SCHOOL ENGLISH (2-3)
- 432g. READING DISABILITIES (2-3)
- 432h. TECHNIQUES IN REMEDIAL READING (2-6)
- 433e. ADVANCED THEORY OF KINDERGARTEN (3)
- 433f. TEACHING CHILDREN'S LITERATURE (2-3)
- 433h. PROBLEMS OF ELEMENTARY SCHOOL ARITHMETIC (2-3)

## EDUCATION

- 433n. TEACHING SOCIAL STUDIES IN THE ELEMENTARY GRADES (2-3)
- 433w. TEACHING SOCIAL STUDIES IN THE HIGH SCHOOL (2-3)
- 433y. TEACHING MATHEMATICS IN THE SECONDARY SCHOOL (3)
- 438. TEACHING SCIENCE IN SECONDARY SCHOOLS (2-3)
- 438e. TEACHING SCIENCE IN THE ELEMENTARY SCHOOL (1-3)
- 439. TEACHING TRAFFIC SAFETY AND AUTOMOBILE OPERATION (3)
- 440. ORGANIZATION AND SUPERVISION IN SAFETY EDUCATION (3)
- 442. ELEMENTARY EDUCATION (2-3)
- 445. PRODUCTION OF VISUAL AND AUDITORY MEDIA (2-9)
  - Unit A. Preparation of Educational Still Pictures (2-3)*
  - Unit B. Scripting and Shooting Educational Motion Pictures (2-3)*
  - Unit C. Editing and Sound Recording in the Production of Educational Motion Pictures (2-3)*
- 446. EDUCATIONAL TESTING PROGRAMS (3)
- 449a. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE ELEMENTARY SCHOOL (3)
- 449b. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE ELEMENTARY SCHOOL (3)
- 449c. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE SECONDARY SCHOOL (3)
- 449d. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE SECONDARY SCHOOL (3)
- 453. GUIDANCE PRINCIPLES AND PRACTICES (3)
- 454. EXTRACURRICULAR ACTIVITIES IN THE JUNIOR AND SENIOR HIGH SCHOOL (2-3)
- 456. PRINCIPLES AND PROBLEMS IN BUSINESS EDUCATION (1-3)
- 459. IMPROVEMENT OF INSTRUCTION IN BUSINESS SKILL SUBJECTS (1-3)
- 460. CURRICULUMS IN BUSINESS EDUCATION (3)
- 461. IMPROVEMENT OF INSTRUCTION IN BASIC BUSINESS SUBJECTS (3)
- 462. TEACHING OF SHORTHAND AND TYPEWRITING (3)
- 463. TEACHING OF BOOKKEEPING (3)
- 464. METHODS OF TEACHING DISTRIBUTIVE EDUCATION (3)
- 466. TEACHING OF OFFICE PRACTICE (3)
- 467. TEACHING OF SHORTHAND (2-3)
- 468. TEACHING OF TYPEWRITING (2-3)
- 470. EDUCATIONAL STATISTICS AND MEASUREMENTS (2-3)
- 472. MEASUREMENT OF ACHIEVEMENT IN THE SECONDARY SCHOOL (2-3)
- 474. TEACHING AND GROUP GUIDANCE ABOUT OCCUPATIONS (3)
- 475. MEASUREMENT OF ACHIEVEMENT IN THE ELEMENTARY SCHOOL (2-3)
- 480. EDUCATIONAL ADMINISTRATION (2-3)
- 487. PROBLEMS IN VISUAL AND OTHER SENSORY AIDS IN EDUCATION (1-14)
  - Unit A. Organization and Administration of Visual-Sensory Aids Programs (1-3)*
  - Unit B. Motion Pictures in Education (2-3)*
  - Unit C. Radio and Television in Education (3)*
  - Unit D. Still Pictures (1-2)*
  - Unit E. Advanced Audio-Visual Equipment (3)*
- 490. PHILOSOPHIC BASIS OF EDUCATION (3)
- 493. CHARACTER EDUCATION (2-3)
- 494. RELIGIOUS EDUCATION (2-3)
- 497. WORKSHOP IN SELECTED STUDIES IN ELEMENTARY AND SECONDARY EDUCATION (1-6)
- 498. PRACTICUM IN THE EDUCATION OF ATYPICAL CHILDREN (1-8)
- 499. ATYPICAL CHILDREN AND EDUCATIONAL ADJUSTMENTS (3)



501. **INTRODUCTION TO THE ADVANCED STUDY OF EDUCATION (1-3)** Methods of educational research; criticism of studies and theses in education; initiating research projects; summarizing results of research. Prerequisite: Ed. 470 or Psy. 415.
502. **SUPERVISED EXPERIENCE IN STUDENT COUNSELING (3)** Practice in the application of guidance principles and methods to cases counseled under supervision; case conferences; seminar in guidance techniques. Prerequisite: Ed. 453.
503. **SUPERVISION OF GUIDANCE WORKERS (3)** Practical experience in supervising and evaluating work of counselors. Prerequisite: Ed. 502.
504. **ORGANIZATION AND ADMINISTRATION OF GUIDANCE PROGRAMS (3)** Principles, organization, personnel, functions, integration with school program, evaluation. Prerequisite: Ed. 453.
505. **OCCUPATIONAL AND EDUCATIONAL INFORMATION (3)** Occupational information for guidance purposes, educational information related to vocational choice and preparation. Prerequisite: Ed. 453.
506. **STUDENT ANALYSIS PROCEDURES FOR COUNSELORS (3)** Collection and use of data basic to the counselor's understanding of individuals; the counseling interview and techniques other than testing.
507. **GUIDANCE SERVICES IN ELEMENTARY EDUCATION (3)** Guidance services to elementary school students; guidance opportunities for elementary teachers and principals.
509. **CONTRIBUTIONS OF PROFESSIONAL PERSONNEL TO VOCATIONAL REHABILITATION (3)** Contributions of medical, social, psychological, and other specialists through the team approach; professional ethics, medical problems. Prerequisites: Ed. 408, 453.
510. **INTERNSHIP IN PROFESSIONAL EDUCATION (1-9)** Internship to take place in schools or educational situations where not regularly employed under supervision of graduate faculty.  
*Unit A. Administration and Supervision (1-6)*  
*Unit B. College Teaching (3-6)*  
*Unit C. Public School Research (3-6)*  
*Unit D. Elementary Teaching (3-6)*  
*Unit E. Secondary Teaching (3-6)*  
*Unit F. Art Teaching and Supervision (3-6)*  
*Unit G. Business Education Supervision (3-6)*  
*Unit H. Special Education Supervision (3-6)*  
*Unit I. Audio-Visual Education (3-6)*
511. **SUPERVISED PRACTICUM IN REHABILITATION COUNSELING (1-6)** Application of principles and techniques of rehabilitation counseling to cases involving handicapped individuals. Prerequisites: Ed. 408, 453.
512. **PROFESSIONAL EXPERIENCE IN REHABILITATION COUNSELING (1-6)** Supervised internship with responsibility for a regular case load. Prerequisite: Ed. 511.
515. **COMPARATIVE EUROPEAN EDUCATION (3)** Educational policies and practices in school systems in western and central European nations. Prerequisite: Psy. 14.
516. **SOCIAL FOUNDATIONS OF EDUCATION (2-4)** Social institutions and functions and their relationship to public education; an analysis of the functions assignable to formal education. Prerequisites: Ed. 25, Psy. 14.



## EDUCATION

517. **EVOLUTION OF EDUCATIONAL THOUGHT (2-3)** Rise of formal educational philosophy from Plato to John Dewey; preliminary reference to Chinese, Hindu, Chaldean, Persian, Hebrew, and Egyptian theories.
523. **LABORATORY IN ORGANIZATIONAL ASPECTS OF MATERIALS OF INSTRUCTION (1-3)** Organizing, storing, circulating, and maintaining instructional material in an instructional materials library. Prerequisites: Ed. 424, 585. Conference 1 hour, alternate weeks by appointment.
524. **SEMINAR IN CURRICULUM MATERIALS AND THEIR UTILIZATION (3)** Advanced detailed analysis of mass communication media; relationships among these and educational objectives, individual differences in learners, and ideas to be communicated. Prerequisites: Ed. 424, 585, 6 credits in educational psychology.
525. **MODERN TENDENCIES IN EDUCATIONAL METHOD (2-3)** Study of science supporting dynamic instruction; principles of teaching as guides; analysis of modern procedures; understanding of learning; substance versus plans. Prerequisite: 12 credits of undergraduate work in education.
527. **PROBLEMS IN THE EDUCATION OF THE MENTALLY RETARDED (1-4)** Study of existing curriculums, instructional practices, educational programs; experimentation in curriculum building and materials construction. Prerequisites: Ed. 426 or 583, Unit P, and Ed. 427 and teaching experience.
529. **PROBLEMS IN THE EDUCATION OF THE MENTALLY GIFTED (1-4)** Analysis of educational needs of mentally gifted; curriculum construction and curricular materials. Prerequisites: teaching experience and Ed. 426 or 583, Unit P, and 429.
532. **SUPERVISION OF STUDENT TEACHERS (3)** A course in supervision for master teachers, department heads, and college teachers with supervisory responsibilities in teacher education. Prerequisite: teaching experience and 18 credits in education, including at least 5 in methods.
- 534a. **READING CLINIC PRACTICE: ANALYSIS OF READING DISABILITIES (1-9)** A laboratory course consisting of analysis of extreme reading disabilities and recommended remedial procedures; experience in preparation of case reports. Prerequisite: Ed. 432g.
- 534b. **READING CLINIC PRACTICE: REMEDIAL PROCEDURES (1-9)** Practicum in special classes for reading disabilities; corrective and remedial procedures; specific procedures for correction of various types of reading disabilities. Prerequisite: Ed. 432g or 534a.
535. **SEMINAR ON READING INSTRUCTION (2-12)** Designed to appraise significant researches and to outline procedures and materials for research; reading readiness, word preception, basic reading skills, vocabulary development. Prerequisite: Ed. 432b or 432c.
536. **READING CLINIC RESEARCH (1-15)** Prerequisites: Ed. 432b; or Ed. 432c, 432g.
537. (Bot. 537, Zool. 537). **WORKSHOP IN THE BIOLOGICAL SCIENCES (3)** Projects designed for teachers of biology in the secondary schools.
540. **PROBLEMS OF ELEMENTARY EDUCATION (2-3)** Problems seminar for experienced educators. Prerequisite: 12 credits in education and psychology, including 6 in elementary education.

541. SEMINAR IN CONTEMPORARY ISSUES IN ELEMENTARY EDUCATION (1-3) Conferences and discussions designed to meet the needs of experienced teachers and principals in the field of elementary education. Prerequisite: 6 credits in elementary education and teaching experience.
546. ELEMENTARY SCHOOL PRINCIPAL AS SUPERVISOR (2-3)
548. ORGANIZATION OF THE ELEMENTARY SCHOOL CURRICULUM (2-3) Principles underlying curriculum construction. Primarily for elementary education majors. Prerequisite: Ed. 31 or teaching experience.
550. PROBLEMS IN MODERN SECONDARY EDUCATION (1-4) Historical, psychological, social, and economic factors influencing secondary education; required as basic course of all graduate students in secondary education. Prerequisite: secondary school teaching.
551. SEMINAR IN CONTEMPORARY ISSUES IN SECONDARY EDUCATION (2-9)
- Unit A. The Secondary School Curriculum (2-3)* Principles and philosophy of curriculum construction. Each student works out an individual problem in the secondary school curriculum. Prerequisites: 12 credits in education and psychology, and teaching experience.
- Unit B. Laboratory Studies in Application of Educational Method (2-3)* Analysis and application of outstanding studies in secondary education; integration of results of educational research with public school procedures. Prerequisites: 12 credits in education and psychology, and teaching experience.
- Unit C. Organization and Administration of Secondary Education (2-3)* Problems in reorganization of secondary education, with particular reference to philosophy, organization, and teaching problems of the junior high school. Prerequisites: 12 credits in education and psychology and teaching experience.
556. THE SECONDARY SCHOOL PRINCIPAL AS SUPERVISOR (2-3) Improvement of instruction; improvement of teachers in service; evaluation of teaching procedures; methods of supervision; selection and use of textbooks. Prerequisite: three years' teaching experience.
561. THE COMMUNITY COLLEGE AND POST-SECONDARY SCHOOL EDUCATION (2-3) Philosophy, organization, and character of school programs needed to meet educational needs of those who desire to continue their education on the post-secondary school level. Prerequisites: Ed. 480, 550; Psy. 414 or educational experience.
562. THE INSTRUCTIONAL PROGRAM IN COMMUNITY COLLEGES AND POST-SECONDARY EDUCATION (2-3) Course offerings, curriculums, instructional materials and procedures, guidance, extracurricular activities, student personnel, evaluation of results, and faculty qualifications. Prerequisites: Ed. 480, 550; Psy. 414 or educational experience.
563. THE PROFESSIONAL EDUCATION OF TEACHERS (3) Development and present status of teacher education; objectives and standards; selection and guidance of students; personnel problems in relation to staff. Prerequisite: 6 credits in advanced courses in education and a course in educational psychology.
564. RECENT TRENDS IN HIGHER EDUCATION (2-3) Factors affecting current college enrollment, organization, administration, support, and curriculums, with special emphasis on general education, its development, aims, and forms.



## EDUCATION

565. THE PRINCIPLES OF COLLEGE TEACHING (2-3) Principles involved in teaching at the college level; effective use of teaching aids; criteria used in evaluation.
566. STUDENT PERSONNEL PROGRAMS AT THE COLLEGE LEVEL (2-3) Student personnel services in higher education; organization of student advisory programs; use of personnel data; co-curricular activities; student welfare.
567. GROWTH AND ORGANIZATION OF HIGHER EDUCATION (2-3) Growth of higher education; influence of church, state, federal government; educational, social, and economic factors that have affected curriculums and organization of institutions.
568. CURRICULUMS IN HIGHER EDUCATION (2-3) Various types of curriculums and philosophies underlying them; ways in which curriculums are developed; elective versus required courses; evaluation of achievement.
569. SEMINAR IN COLLEGIATE EDUCATION (1-6) Special topics in higher education. Prerequisite: Ed. 567.
574. ADVANCED EDUCATIONAL STATISTICS (2-4) Appropriate measures and devices for experimental research in education including correlation measures, curve fitting, and analysis of variance. Prerequisite: 12 credits of graduate work in education including Ed. 470 or Psy. 415.
575. ADMINISTRATION AND SUPERVISION IN BUSINESS EDUCATION (3) Work of administrators, supervisors, and others responsible for improvement of instruction in business education; use of vocational testing; job analysis. Prerequisite: 6 credits in secondary education.
576. INTRODUCTION TO RESEARCH IN BUSINESS EDUCATION (3) Methods of research in business education; opportunity to compile annotated bibliographies on current problems; analysis and evaluation of significant research.
577. EVALUATION OF RESEARCH AND EMPIRICAL LITERATURE IN BUSINESS EDUCATION (3) Application of evaluation methods to current literature in business education; special attention to research studies. Prerequisite: Ed. 576.
578. SEMINAR IN BUSINESS EDUCATION (1-6) Intended for graduate students preparing theses or final documents, or for those working on special studies in business education. Prerequisite: Ed. 577.
580. SEMINAR IN SCHOOL ADMINISTRATION (1-6) Efficiency in supervision, methods of diagnosis and evaluation of teaching and learning procedure, improving instruction, maintaining teacher morale, stimulating co-operative work. Prerequisites: Ed. 480, 6 credits of Ed. 583.
582. EDUCATIONAL SURVEY TECHNIQUES (2-3) Methods for appraisal of an educational program; planning for expansion, consolidation, or reduction of educational offerings. Prerequisites: Ed. 480, 6 credits of Ed. 583.
583. PROBLEMS IN ADMINISTRATION AND SUPERVISION (2-27) Prerequisite: Ed. 480 or teaching or administrative or supervisory experience.
- Unit A. The Educational Plant (2-3)* School plant needs in terms of school population and curriculums; the building survey, developing a plant program, the building site, plant utilization, operation and maintenance, heating and ventilation, equipment, school building costs and finance.



*Unit B. Public Relations for School Administrators (2-3)* Utilization of public participation in the formulation of school policies; relation of the school staff to the public and techniques for informing the public about what schools can do.

*Unit C. Public School Finance (2-3)* Financing of public education in relation to organization and control; the conceptual basis for local financial administration; taxation, state and federal aid, school revenue, and money management.

*Unit F. State and National Education Programs (2-3)* Existing state and federal functions and relations to education; proposed programs. Prerequisite: previous work in school administration.

*Unit I. Administration of Adult Education in the Public Schools (3)* The organization of a program of adult education; its legal status, finances, selection of teachers, learning personnel, housing, and other administrative problems connected with adult education.

*Unit M. Legal Aspects of School Administration (3)* Legal bases for the organization and administration of school districts and schools; the powers, rights, privileges, and responsibilities of school corporations, school boards, administrators, and personnel; the law and fiscal policies; the course of study; textbooks; contracts; taxes; torts; records; agents; and the judicial decisions involved.

*Unit P. The Administration of Public School Education for Atypical Children (2-3)* Problems connected with the instituting and organizing of classes for atypical children: the legal phases, finances, teaching personnel, pupil personnel, housing, equipment, courses of study, curriculums, etc.

*Unit Q. Dynamic Factors in School Administration (2-3)* Factors which make for the improvement of public schools; influences with which administrators may work to improve the schools in their local situations; subjection of data on individual administrative situations to scientific check.

*Unit R. Public School Business Administration (2-3)* Business management applied to school management problems: budgeting, accounting, purchasing, insurance, school equipment, cafeteria management; transportation, salaries, personnel management, and auxiliary and coordinate agencies. Prerequisite: Ed. 583, Unit C.

585. CURRICULUM CONSTRUCTION (2-3) Functions of administrators, supervisors, teachers, pupils, and laymen in curriculum building to meet pupil and community needs.

586. PRINCIPLES OF SCHOOL SUPERVISION (2-3) Organization of supervision; planning the supervisory program; developing standards of teaching and learning; improvement of learning through tests and teacher rating. Prerequisites: 18 credits in education and 3 years' teaching experience.

587. THE SECONDARY SCHOOL PRINCIPAL AS ADMINISTRATOR (2-4) Problems of schedule making, teachers' meetings, curriculum making and revision, organization of extracurricular and guidance programs. Prerequisite: teaching experience.

589. THE ELEMENTARY SCHOOL PRINCIPAL AS ADMINISTRATOR (2-3) Duties of the elementary school principal in organizing and administering his school.

## EDUCATION

590. ADVANCED PHILOSOPHY OF EDUCATION (2-4) Analysis of educational policy and practice for philosophic consistency and commitment; philosophical implication in selected educational literature.
591. EDUCATION IN RUSSIA, ASIA, AND THE MIDDLE EAST (2-3) Current educational activities in Soviet Russia and other eastern European countries; the Middle East, North Africa, and the Far East.
592. EDUCATION IN THE LATIN-AMERICAN COUNTRIES (2-3) Recent educational progress in Central and South America, with special reference to Mexico, Cuba, Puerto Rico, Brazil, Chile, and Argentina.
594. SEMINAR IN EDUCATION (1-3) Conferences and discussions designed to meet the need for special study of particular fields in education. Prerequisite: 12 credits of graduate work in education.
597. WORKSHOP IN CURRENT EDUCATIONAL PROBLEMS (1-6) For administrators, supervisors, experienced elementary and secondary teachers, guidance workers; administrative, supervisory, and instructional problems involved in an emerging educational program. Prerequisite: 12 credits of graduate work in education.
598. PROBLEMS, PROJECTS, AND AREA STUDIES IN EDUCATION (1-6) Independent work in the study of topics in education or the development of new curriculums, materials, or procedures for teaching. Prerequisites: 12 credits of graduate work in education and approval of the department head.

## ELECTRICAL ENGINEERING

ARTHUR H. WAYNICK, *Head of the Department*  
105 Electrical Engineering Building

Graduate work leading to the M.S. and Ph.D. degrees is offered. Course offerings and research facilities are available in the following areas: information theory, microwave theory and techniques, networks, computers (including digital, analog, and network analyzer), control, power conversion, servomechanisms, tubes and transistors, dynamical machine analysis, power dispatching, relay protection, and wave propagation.

The entering student must hold a bachelor's degree in engineering or science and have satisfactorily completed undergraduate course work in electrical circuits, machinery, and electronics.

### ELECTRICAL ENGINEERING (E E)

415. ILLUMINATION (3)
- 421a,b,c,d. ELECTRICAL ENGINEERING PROBLEMS (2-12)
422. CREATIVE ELECTRICAL ENGINEERING (3)
423. TRANSIENT PHENOMENA (3)
424. POWER FREQUENCY ELECTRONICS (3)
425. SYMMETRICAL COMPONENTS (3)
426. TRANSISTORS (3)
428. SERVOMECHANISMS (3)
432. ULTRA-HIGH-FREQUENCY TECHNIQUES (3)
435. ENGINEERING ANALYSIS (3)
436. DESIGN, CONSTRUCTION, AND TESTING OF VACUUM TUBES (3)

## ELECTRICAL ENGINEERING

- 438. FUNDAMENTALS OF ELECTRIC WAVES (3)
- 439. PULSE TECHNIQUES (3)
- 440. VACUUM-TUBE CIRCUITS I (3)
- 441. VACUUM-TUBE CIRCUITS II (3)
- 450. ELECTRICAL NETWORK THEORY (3)
- 460. HIGH-VOLTAGE ENGINEERING (3)
- 461. FUNDAMENTALS OF POWER SYSTEM STABILITY (3)
- 470. ELECTRONIC ANALOG COMPUTERS (3)
- 471. LOGICAL DESIGN OF DIGITAL COMPUTERS (3)
  
- 520. SEMINAR (1) Required of all graduate students in electrical engineering. Conferences, reading, and presentation of technical papers.
  
- 521. ADVANCED ELECTRICAL ENGINEERING PROBLEMS (2-12)
  
- 523. TRANSIENTS IN LINEAR SYSTEMS (3) Transient response of linear electric circuits and electromechanical systems including the application of operational methods of analysis to electrical and electromechanical problems. Prerequisite: E.E. 423.
  
- 524. ENGINEERING ELECTRONICS (3) Special problems dealing with design and application of electronic devices and systems; emphasis upon individual projects closely related to other phases of the student's graduate program.
  
- 525. SYMMETRICAL COMPONENTS (3) Polyphase circuits and machines under unbalanced conditions of operation including effects of rotating machines upon distribution and transmission system performance; characteristics of phase converters and single-phase operation of polyphase systems. Prerequisite: E.E. 425.
  
- 528. SERVOMECHANISMS (3) Advanced treatment of transient and steady-state behavior of closed-cycle control systems with special attention to stability and design of stabilizing controllers. Prerequisite: E.E. 428.
  
- 532. ULTRA-HIGH-FREQUENCY ENGINEERING (4) Theory of transmission lines, wave guides, resonant cavities, antennae, and wave propagation. Prerequisite: E.E. 432.
  
- 535. ENGINEERING ANALYSIS (3) Engineering applications of complex variables, conformal mapping methods and potential plotting. Laplace transform methods and stability criteria. Prerequisite: E.E. 435.
  
- 538. ELECTROMAGNETIC ENGINEERING (3) Electrical and magnetic fields, using the Maxwell-Lorentz equations as applied to vector fields and special solutions for antennae, wave guides, and other engineering applications. Prerequisite: E.E. 438.
  
- 550. COMMUNICATION NETWORKS (3) Methods of filter design using lattice networks; effects of dissipation on characteristics of filter networks; transient response of networks and design of equalizers. Prerequisite: E.E. 450.
  
- 570. ADVANCED ELECTRONIC ANALOG COMPUTERS (3) Theory and design of linear and nonlinear function generators for electronic analog computers; methods of synthesizing physical systems. Prerequisite: E.E. 470.
  
- 571. DIGITAL COMPUTATION AND CONTROL (3) Methods of analysis of digital computers; analysis of sampled-data systems for real-time control purposes.



## ENGINEERING MECHANICS

JOSEPH MARIN, *Head of the Department*  
204 Engineering A

The department offers graduate study programs leading to the M.S. and Ph.D. degrees. Research and graduate study are available in the following fields of engineering mechanics: dynamics and vibrations, theory of elasticity and strength of materials, experimental stress analysis, theory of plasticity and mechanical properties of materials. The department also offers a fluid mechanics option for both the M.S. and the Ph.D. degrees.

In order to be admitted to graduate work in engineering mechanics, the student must have a bachelor's degree in engineering or in some field of science. It is also necessary for him to have satisfactorily completed undergraduate courses in statics, dynamics, strength of materials, and materials of engineering.

## ENGINEERING MECHANICS (E MCH)

- |                                                                                                                                                                                                                                                                                                                                      |                                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| 400. ADVANCED STRENGTH OF MATERIALS (3)                                                                                                                                                                                                                                                                                              | <i>Mr. Hardenbergh</i>            |
| 401. ELEMENTS OF VIBRATIONS (3)                                                                                                                                                                                                                                                                                                      | <i>Mr. Vierck</i>                 |
| 402. APPLIED AND EXPERIMENTAL STRESS ANALYSIS (3)                                                                                                                                                                                                                                                                                    | <i>Mr. Oppel</i>                  |
| 403. MECHANICS OF THE SOLID STATE (3)                                                                                                                                                                                                                                                                                                | <i>Mr. Marin</i>                  |
| 404. RESEARCH IN ENGINEERING MECHANICS (1-6)                                                                                                                                                                                                                                                                                         |                                   |
| 407. NUMERICAL METHODS OF ANALYSIS (3)                                                                                                                                                                                                                                                                                               | <i>Mr. Vierck</i>                 |
| 408. ELASTICITY AND ENGINEERING APPLICATIONS (3)                                                                                                                                                                                                                                                                                     | <i>Messrs. Hardenbergh and Hu</i> |
| 410. MECHANICS OF SPACE FLIGHT (3)                                                                                                                                                                                                                                                                                                   | <i>Mr. Oppel</i>                  |
| 500. ADVANCED MECHANICS OF MATERIALS (3-6) Strain energy methods; special problems in bending and torsion; curved bars, beams on elastic foundations; thick-walled cylinders, shrink-fit assemblies, and rotating discs; thin-walled pressure vessels; bending of thin plates; buckling of bars and plates. Prerequisite: E.Mch. 13. |                                   |
|                                                                                                                                                                                                                                                                                                                                      | <i>Mr. Marin</i>                  |
| 504. APPLIED ELASTICITY (3) Analyses of stress and strain in two dimensions; problems in elasticity and elastic stability; emphasis on applications to machine and structural design. Prerequisite: E.Mch. 13.                                                                                                                       |                                   |
|                                                                                                                                                                                                                                                                                                                                      | <i>Mr. Oppel</i>                  |
| 506. EXPERIMENTAL STRESS ANALYSIS (3) Experimental methods of stress determination including photoelasticity, stress coat and electric strain gauge techniques; stress analogies; strain rosettes for combined stress determinations. Prerequisite: E.Mch. 408 or 507.                                                               |                                   |
|                                                                                                                                                                                                                                                                                                                                      | <i>Mr. Oppel</i>                  |
| 507. THEORY OF ELASTICITY AND APPLICATIONS (3) Equations of equilibrium and compatibility; stresses and strains in beams, curved members, rotating discs, thick cylinders, torsion and structural members. Prerequisite: E.Mch. 13.                                                                                                  |                                   |
| 508. THEORY OF ELASTIC STABILITY AND APPLICATIONS (3) Buckling of slender and short members; buckling of I-beams; stability of thin-walled constructions; thin-walled cylinders subjected to internal pressures; applications to structural parts including aircraft members. Prerequisites: E.Mch. 12, 13.                          |                                   |
| 509. THEORY OF PLATES AND SHELLS (3) Bending of circular and rectangular plates; buckling of plates; plates on elastic foundations; deformation of shells without bending; applications to engineering problems. Prerequisite: E.Mch. 13.                                                                                            |                                   |

514. **ENGINEERING MECHANICS SEMINAR** (1 per semester) Current literature and special problems in engineering mechanics.
516. **MATHEMATICAL THEORY OF ELASTICITY** (3) Stress and strain dyadics; conditions for single valued displacement; incompatibility dyadic; generalized Hooke's Law; uniqueness theorem; special topics in elasticity. Prerequisites: Math. 417, 405.
520. **ADVANCED DYNAMICS** (3) Dynamics of a particle and of rigid bodies: Newtonian equations in moving co-ordinate systems; Lagrange's and Hamilton's equations of motion; special problems in vibrations and dynamics. Prerequisites: E.Mch. 12, Math. 44 or 431. *Mr. Davids*
522. **THEORY OF VIBRATIONS** (3) Mathematical theory of vibrating systems; damping phenomena; forced vibrations; analogy between mechanical and electrical vibrations; transverse and torsional oscillation of shafts; vibration of strings, beams, membranes, and plates. Prerequisites: E.Mch. 13, Math. 44 or 431. *Mr. Vierck*
523. **RELAXATION METHODS** (3) Relaxation methods compared to iteration and other numerical methods of analysis; application to elasticity, plasticity, stability, fluid flow, heat transfer, and related fields. Prerequisites: E.Mch. 13 or 111, Math. 44. *Mr. Vierck*
524. **MATHEMATICAL METHODS IN ENGINEERING** (3-6) Prerequisite: Math. 451 or E.E. 435 or M.E. 452. *Mr. Davids*  
*Unit A* (3) Matrix and tensor analysis, finite differences, relaxation, perturbation, and other approximate methods in solution of various engineering problems.  
*Unit B* (3) Energy methods, potentials, application to torsion problems, non-linear problems, analogies and dimensional analysis, Bessel and other special functions, harmonic analysis.
526. **NONLINEAR MECHANICS** (3) Integral curves, singular points, self-sustained oscillations, stability problems, Hill's and Van der Pol's equation, mechanical and electrical applications. Prerequisite: E.Mch. 522.
528. **EXPERIMENTAL METHODS IN VIBRATIONS** (3) Investigation of one or more degrees of freedom, free and forced mechanical vibrations, vibration properties of materials, vibration techniques in nondestructive testing. Prerequisite: E.Mch. 401 or 522. *Mr. Brennan*
529. **ENGINEERING APPLICATIONS OF SONICS** (3) Sound and ultrasound in engineering and science; principles, radiation, transducers, devices for sonic processing and testing. Prerequisite: Phys. 443.
530. **SOLID STATE MECHANICS** (3) Relation between solid state physics and mechanics; mechanical properties for static, fatigue, creep, and impact conditions; high temperature properties; applications. Prerequisite: E.Mch. 14. *Mr. Marin*
- 531a. **THEORY OF PLASTICITY AND APPLICATIONS A** (3) Yield conditions; theories of plasticity; differential equation methods; analogy methods; applications to bending, torsion, thick-walled cylinders and discs. Prerequisite: E.Mch. 504 or 507. *Messrs. Hu and Marin*
- 531b. **THEORY OF PLASTICITY AND APPLICATIONS B** (3) Variational principles; limit design; slip line theory; shake down principle; anisotropic metals; application

## ENGINEERING MECHANICS

to structure design, metal processing, soil mechanics. Prerequisite: E.Mch. 531a.

*Mr. Hu*

533. DETERMINATION OF MECHANICAL PROPERTIES (3) Experimental methods for determining hardness, elastic constants, creep behavior, fatigue strength, plastic flow, and dynamic properties of metals. Prerequisite: E.Mch. 14 or 530.

*Mr. Hu*

534. PHOTOELASTICITY (3) Analysis of polariscopes; isoclinics, isochromatics, and stress trajectories; two- and three-dimensional photoelastic methods; determination of principal stresses; model preparation. Prerequisite: E.Mch. 408 or 507.

*Mr. Oppel*

540. MECHANICS OF CONTINUA (3) Unified mathematical treatment of elements of fluid mechanics and of elasticity and plasticity of solids. Prerequisite: Math. 44 or 431.

550. STUDIES IN ENGINEERING MECHANICS (1-6) Studies in any field of engineering mechanics.

## ENGLISH

ARTHUR O. LEWIS, JR., *in Charge of Graduate Programs*  
221 Sparks Building

Graduate work in English leads to the M.A. and Ph.D. degrees. The student may specialize in English literature, American literature, philology, or rhetoric. It is preferred that an entering student present 24 credits in English, but 18 credits in English exclusive of survey and freshman courses will be accepted. If the student does not present 18 credits in English, he must make up the deficiency early in his graduate work.

### ENGLISH COMPOSITION (E CMP)

404. PUBLIC OPINION AND WRITTEN PERSUASION (3)

*Mr. Graves*

408. ENGLISH GRAMMAR (3)

*Miss McElwee*

418. THE WRITING OF LITERARY CRITICISM (3)

*Mr. Bressler*

442. CONTEMPORARY PROSE STYLE (3)

*Mr. Major*

### ENGLISH LITERATURE (E LIT)

400. TEACHERS' COURSE IN LITERATURE (3)

401. MAIN CURRENTS IN AMERICAN LITERATURE (3)

*Mr. Sutherland*

423. FORMS AND MOVEMENTS OF BRITISH LITERATURE (3)

*Mr. Ridenour*

439. OUR CONTEMPORARIES (3)

440. MASTERS OF BRITISH LITERATURE (3)

441. MASTERS OF AMERICAN LITERATURE (3)

460. LITERARY BIOGRAPHY (3)

464. SPENSER (3)

*Miss Locklin*

466. MILTON (3)

*Mr. Condee*

480. THE DRAMA BEFORE SHAKESPEARE (3)

481. JACOBEAN AND CAROLINE DRAMA (3)

*Mr. Harris*

484. AMERICAN DRAMA (3)

*Mr. Rubin*

486. LATER BRITISH AND IRISH DRAMATISTS (3)

487. MODERN CONTINENTAL DRAMA (3)

488. THE DRAMA FROM DRYDEN TO SHERIDAN (3)

*Mr. Harris*



## ENGLISH (ENGL)

501. MATERIALS AND METHODS OF RESEARCH (3) Bibliography of literary history and criticism; methods of editing and annotating texts; form and materials of dissertations. Required of all graduate students with an English major.  
*Mr. Ridenour*
502. CLASSICAL ORIGINS OF ENGLISH PROSE AND POETIC THEORIES (3) Rhetorical and poetic doctrine of ancient and medieval times.  
*Mr. Reed*
507. RESEARCH PROBLEMS IN ENGLISH (1-6) Methods of research in English, problems of bibliography, and method of evaluating sources and materials.
508. BEOWULF (3) Reading of the text and study of the prominent literary problems and relationships.
509. NONDRAMATIC WRITERS OF THE ELIZABETHAN PERIOD: THE PROSE WRITERS (3)
510. NONDRAMATIC WRITERS OF THE ELIZABETHAN PERIOD: THE POETS (3)  
*Miss Locklin*
514. SHAKESPEARE (3) Special problems in the works of Shakespeare. *Mr. Bowman*
515. THE AGE OF SWIFT (3) Special studies varying from year to year. *Mr. Harris*
516. THE AGE OF JOHNSON (3) The work of Johnson and his circle. *Mr. Mead*
517. BYRON, SHELLEY, AND KEATS (3)  
*Mr. Ridenour*
518. PRE-ROMANTIC WRITERS (3) Development of Romantic ideas in the 18th century.  
*Mr. Ridenour*
519. WORDSWORTH, COLERIDGE, SOUTHEY, AND SCOTT (3)  
*Mr. Ridenour*
530. HISTORY OF THE ENGLISH LANGUAGE (3) Germanic background of English, phonological and morphological developments, dialect differentiations, and principles of linguistic change.  
*Mr. Mead*
531. OLD ENGLISH (3) Old English language and literature with lectures on Old English and Germanic philology.
532. MIDDLE ENGLISH (3) Middle English language and literature with lectures on the development of Old English through Middle English to modern times.  
*Mr. Mead*
534. HISTORICAL ENGLISH GRAMMAR (3) Evolution of the grammatical system of English.  
*Mr. Peck*
535. RENAISSANCE AND MODERN RHETORIC (3) The rhetorical and poetic doctrine of Renaissance and modern times.  
*Mr. Bressler*
540. CHAUCER (3) Analysis of Chaucer's poetry in the light of its background, sources, and subsequent influences.  
*Mr. Mead*
542. PROSE STYLE (3) Development of English prose style.  
*Mr. Major*
543. CAVALIER AND ANGLICAN (3) Poetry and prose of the middle years of the 17th century from the death of Shakespeare to 1660.

## ENGLISH

544. RESTORATION LITERATURE (3) Selected studies of writers in England between 1650 and 1700. *Mr. Harris*
545. POETS OF THE VICTORIAN PERIOD, EXCLUSIVE OF TENNYSON AND BROWNING (3)
546. TENNYSON AND BROWNING (3)
547. PROSE WRITERS OF THE VICTORIAN PERIOD (3)
550. SELECTED STUDIES IN THE BRITISH NOVEL TO 1840 (3) *Mr. Bowman*
551. SELECTED STUDIES IN THE BRITISH NOVEL FROM 1840 TO THE PRESENT (3) *Mr. Sutherland*
562. THE AMERICAN NOVEL (3) *Mr. Werner*
563. AMERICAN ESSAYS (3) Lectures and reports on a special group of essayists. *Mr. Werner*
565. THE AMERICAN SHORT STORY (3) *Mr. Werner*
566. AMERICAN POETRY (3) *Mr. Werner*
567. ANGLO-AMERICAN FOLK SONG (3) Oral tradition of melodies and texts; types, regions, theories. *Mr. Bayard*

## ENTOMOLOGY

BERTIL G. ANDERSON

*Head of the Department of Zoology and Entomology*  
212 Frear Laboratory

Work leading to the M.S. and Ph.D. degrees with a major in entomology is offered with specialization in apiculture, ecology, economic entomology, morphology, physiology, insect resistances of plants, taxonomy, or toxicology of insecticides.

In order to undertake graduate work in this field, a student is required to have had 24 credits in entomology or zoology and related biological sciences; and he should have had chemistry through organic chemistry. Courses in physics and mathematics are also advantageous. A limited deficiency may be made up, without degree credit, while pursuing graduate work.

### ENTOMOLOGY (ENT)

401. MEDICAL AND VETERINARY ENTOMOLOGY (3) *Mr. Frings*
403. SYSTEMATIC ENTOMOLOGY (3) *Mr. Boyle*
405. INSECT MORPHOLOGY (3) *Mr. Rutschky*
407. INSECT ECOLOGY (3)
413. ENTOMOLOGY SEMINAR (1 per semester)
429. PRINCIPLES OF INSECT CONTROL (3) *Mr. Blackburn*
430. INSECT HISTOLOGY (2) *Mr. Rutschky*
431. ENTOMOLOGICAL PROBLEMS (1-6)
445. THE IDENTIFICATION OF INSECTS (3)
505. ADVANCED MORPHOLOGY OF INSECTS (3) Advanced work in either external or internal morphology of insects. Prerequisites: Ent. 403, 405. Spring semester, even years. *Mr. Rutschky*

## ENTOMOLOGY

506. IMMATURE INSECTS (3) The morphology and taxonomy of the immature stages of insects. Prerequisite: 9 credits in entomology. Spring semester, even years.  
*Mr. Blackburn*
508. THE BIOLOGICAL CONTROL OF INSECTS (2) Artificial use of bacteria, fungous diseases, and animals in control of injurious insects; methods and equipment for rearing parasites and predators on a large scale. Prerequisites: Ent. 6, 8, 407.
509. ENTOMOLOGICAL TECHNIQUE (2) For advanced students dealing with special methods of collecting, rearing living insects, preparing and preserving immature stages, keeping records, and preparing illustrations for manuscript. Prerequisite: Ent. 6. Fall semester, odd years.  
*Mr. Coon*
514. ADVANCED SYSTEMATIC ENTOMOLOGY (1-15 per semester) Taxonomy of various orders of insects selected to meet the needs of the individual student. Prerequisites: Ent. 403, 405.
528. INSECT PHYSIOLOGY (4) Normal functions of the insect body. Fall semester, even years.  
*Mr. Smyth*
531. INSECT TOXICOLOGY (2) General principles of toxicology and survey of the actions of substances toxic to insects. Spring semester, odd years.  
*Mr. Smyth*
540. INSECT RESISTANCE IN PLANTS (2) Mechanism, expression, permanence, and measurement of resistance to insects with special reference to farm crops. Spring semester, odd years.  
*Mr. Coon*

## FOODS AND NUTRITION

MIRIAM E. LOWENBERG, *Head of the Department*  
202A Home Economics Building

The M.S. and M.Ed. degrees are offered in foods and in nutrition. The Ph.D. and D.Ed. degrees are offered in the field of nutrition. The M.S. degree in nutrition in public health is offered in a co-operative program with the University of Pittsburgh.

The student may specialize in foods and nutrition to prepare for teaching in high school or for teaching and/or research work in college. She may also prepare for leadership in adult programs. Study at the master's degree level in foods also prepares students for work in commercial food research laboratories. The program in nutrition in public health prepares the student to work in a public health agency. In addition to receiving training in public health, she has the opportunity to further her preparation in foods and nutrition as well as in other areas dealing with families.

The minimum undergraduate preparation for graduate work in foods or nutrition includes 18 credits in physical and biological sciences, of which 9 shall be in inorganic and 3 in biological chemistry, 3 in bacteriology, and 3 in physiology; 9 credits in the social sciences; and 10 in foods and nutrition.

For the major in nutrition in public health the same requirements are necessary in the physical and biological sciences. Twelve credits are required in the social sciences, 7 in foods, and 4 in nutrition.

### FOODS, NUTRITION, AND HEALTH (F N)

400. SPECIAL PROBLEMS IN FOODS AND NUTRITION (1-3)

420. EXPERIMENTAL COOKERY (1-6)

*Miss Olson*



## FOODS AND NUTRITION

421. ADVANCED FOODS (3) *Miss Batjer*  
423. (H.M.F.E. 423). FAMILY FOOD PURCHASING (2)  
425. FOOD PRESERVATION (2) *Miss Hester*  
426. RECENT DEVELOPMENTS IN FOODS (3)  
450. NUTRITION (4) *Miss Padgett*  
451. RECENT DEVELOPMENTS IN NUTRITION (3)  
452. ELEMENTS OF DIET IN DISEASE (3) *Miss Pike*  
455. TEACHING NUTRITION TO BOYS AND GIRLS (3)  
456. NUTRITION IN THE COMMUNITY (3) *Miss Lowenberg*
520. READINGS IN FOODS (2) Critical review and reports of literature on selected food topics. *Miss Hester*  
521. SEMINAR IN FOODS (1-6) Discussion and reports on current research in the foods field. Prerequisite or concurrent: F.N. 520. *Miss Hester*  
522. ADVANCED EXPERIMENTAL FOODS (3) Experimental methods used in measuring the quality of foods; specific problems in food preparation. *Miss Hester*  
530. PROBLEMS IN FOODS AND NUTRITION (1-6)  
531. ADVANCES IN FOODS AND NUTRITION (3) Recent findings in the related areas of foods and nutrition.  
550. READINGS IN NUTRITION (3) Readings and reports of selected topics in nutrition. Prerequisite: F.N. 450. *Miss Padgett*  
551. SEMINAR IN NUTRITION (1-6) Selected topics and recent advances in nutrition.  
552. DIET IN DISEASES (3) Physiological and biochemical problems in metabolic diseases and the nutritional aspects of therapy. *Miss Pike*  
553. NUTRITION OF CHILDREN (3) Nutritional needs of the normal child during prenatal life, infancy, and childhood. Prerequisites: A.B.Ch. 35, F.N. 450. *Miss Padgett*  
555. FIELD WORK IN NUTRITION (2-4) Field problems planned to meet the needs of individual students. Hours and problems to be arranged.  
556. THE SURVEY METHOD IN FOODS AND NUTRITION (2) Study of survey technique as a tool in the assay of food adequacy and nutritional status. *Miss Dodds*  
557. INTERRELATIONSHIPS OF NUTRIENTS (2) Interrelationships of nutrients in the metabolic processes; their significance as applied to nutrition. *Miss Pike*

## FORESTRY

H. NORTON COPE

*Acting Director of the School of Forestry*  
102 Forestry Building

The School of Forestry offers graduate work leading to the M.S. and M.F. degrees with a major in forestry. In the Department of Forest Management a student may specialize in forest management, silviculture, or wildlife management; in the De-

partment of Wood Utilization he may specialize in wood utilization, wood technology, or forest products.

A B.S. degree in forestry normally provides the minimum preparation for specialization in any of the above areas except wood utilization. A B.S. degree in wood utilization, or a similar program emphasizing mathematics and basic engineering courses, provides the minimum preparation for specialization in wood utilization and is acceptable for advanced work in wood technology and forest products. Preparation for graduate work in wildlife management may be secured in any program which has emphasized land management and has included work in dendrology, silvics, forest measurement, and forest management.

Students with limited deficiencies may be admitted but must make up deficiencies without degree credit.

#### FORESTRY (FOR)

- |                                                                                                                                                                                                                                            |                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| 421. REGIONAL SILVICULTURE (4)                                                                                                                                                                                                             | <i>Mr. Cope</i>     |
| 427. FOREST RANGE MANAGEMENT (3)                                                                                                                                                                                                           | <i>Mr. Chisman</i>  |
| 445. IMPROVEMENTS (3)                                                                                                                                                                                                                      |                     |
| 450. ADVANCED MENSURATION (3)                                                                                                                                                                                                              |                     |
| 455. FOREST PHOTO INTERPRETATION (3)                                                                                                                                                                                                       |                     |
| 466. FOREST MANAGEMENT AND MANAGEMENT PLANS (4)                                                                                                                                                                                            |                     |
| 469. PROBLEMS IN FORESTRY (1-9)                                                                                                                                                                                                            |                     |
| 480. POLICY AND ADMINISTRATION (3)                                                                                                                                                                                                         |                     |
| 481. FOREST WATERSHED MANAGEMENT (3)                                                                                                                                                                                                       |                     |
| 491. LOGGING AND LUMBERING (3)                                                                                                                                                                                                             | <i>Mr. Schmidt</i>  |
| 497. SMALL SAWMILLS (3)                                                                                                                                                                                                                    | <i>Mr. Schmidt</i>  |
| 504. RESEARCH METHODS IN FORESTRY (2-6 per semester) Review of methods employed in conducting forestry research.                                                                                                                           |                     |
| 508. FOREST ECOLOGY (2-4) Organization, development, and classification of forest communities.                                                                                                                                             |                     |
| 509. COVERT MANAGEMENT (2) Management of forest associations for maintenance and development of wildlife. Prerequisite: For. 508.                                                                                                          |                     |
| 510. FORESTRY SEMINAR (1-2 per semester) Current problems of forest research presented as weekly seminar reports. May be repeated with additional credit for each semester's work.                                                         |                     |
| 550. FOREST MENSURATION (2-8 per semester) Research in some chosen field. Prerequisite: For. 450.                                                                                                                                          |                     |
| 560. FOREST MANAGEMENT (3-8) Special topics in forest management and research in some chosen field. Prerequisite: For. 466.                                                                                                                |                     |
| 575. APPLICATIONS OF FOREST ECONOMICS AND FINANCE (3 per semester) Survey of situations in forestry where business problems and particular circumstances of production, value, and costs are currently significant. Prerequisite: For. 70. |                     |
|                                                                                                                                                                                                                                            | <i>Mr. Humphrey</i> |
| 590. THE LUMBER INDUSTRY (2-4) Relation of the lumber industry to national economy and world trade; lumbermen's associations; lumber accounts.                                                                                             |                     |
| 591. PROBLEMS IN LOGGING AND LUMBERING (2-6) Research in some chosen phase of lumbering. Prerequisite or concurrent: For. 590.                                                                                                             |                     |

## FORESTRY

### WOOD UTILIZATION (W U)

404. MECHANICAL PROPERTIES OF WOOD (3) *Mr. Nearn*  
405. VENEER AND PLYWOOD (3) *Messrs. Jorgensen and Nearn*  
431. PROBLEMS IN FOREST PRODUCTS (3-6) *Messrs. Norton and Nearn*  
435. SEASONING AND PRESERVATION (3) *Mr. Nearn*  
437. ADVANCED WOOD TECHNOLOGY (3) *Messrs. White and Jorgensen*  
462. DEFECTS IN WOOD (3) *Mr. Norton*  
492. LUMBER DISTRIBUTION (3) *Mr. Schmidt*  
495. MILLING AND COSTS IN THE FOREST PRODUCTS INDUSTRIES (3) *Mr. Schmidt*
502. WOOD FIBERS (3-5) Identification and physical and chemical characteristics of wood fibers used for pulp, either for paper or as a source of cellulose. Pulping quality, fiber measurements. *Mr. White*
510. WOOD UTILIZATION SEMINAR (1-2 per semester)
530. PROBLEMS IN WOOD UTILIZATION (3-6 per semester) Prerequisite: W.U. 431. *Mr. Norton*
531. STRUCTURAL USES OF WOOD AND WOOD PRODUCTS (3-6 per semester) Wood as a construction material; testing techniques for structural timbers and wood assemblies; use of laminated wood, ring connectors, and other types of special construction. Prerequisite: W.U. 404. *Mr. Norton*
532. LAMINATES (3-6 per semester) Advanced and special studies in fabrication and use of plywood, laminated wood, paper-base laminates, and wood-to-metal bonding. Prerequisite: W.U. 405. *Mr. Norton*
535. CONDITIONING TREATMENTS FOR WOOD (3-6 per semester) Advanced study and problems in preservative, seasoning, and other special treatments for wood and wood products. Prerequisite: W.U. 435. *Mr. Norton*

## FUEL TECHNOLOGY

PHILIP L. WALKER, JR., *Head of the Department*  
212 Mineral Industries Building

Graduate work in this department leads to the M.S. and Ph.D. degrees. The course program includes the chemistry and combustion of solid, liquid, and gaseous fuels. There is opportunity for research in the chemistry of coals and carbons and in the combustion of fuels.

A bachelor's degree with undergraduate training in one of the following fields is necessary for admission: chemistry, chemical engineering, physics, or fuel technology.

### FUEL TECHNOLOGY (F T)

400. FUEL TECHNOLOGY RESEARCH AND DESIGN (1-3)  
401. FUEL GASES AND GASIFICATION (2) *Mr. Walker*  
402. CHEMICALS FROM FUELS (2) *Mr. Kinney*  
405. COMBUSTION CALCULATIONS (3)  
406. GASEOUS COMBUSTION (3) *Mr. Palmer*  
408. COMBUSTION TECHNOLOGY (4) *Mr. Spicer*  
409. THERMAL PROCESSING OF FUELS (2) *Mr. Polansky*



## FUEL TECHNOLOGY

410. THERMAL PROCESSING LABORATORY (2) *Mr. Polansky*  
411. JET AND ROCKET FUELS (2) *Mr. Palmer*  
412. CATALYTIC PROCESSES IN THE FUEL INDUSTRIES (2)
503. CHEMICAL CONSTITUTION AND SCIENTIFIC CLASSIFICATION OF COAL (3-6) Chemistry of plant constituents in relation to coal and the coalification process; constitution of coal as deduced by chemical methods; scientific classification of coals. Prerequisite: Chem. 31. *Mr. Kinney*
506. ADVANCED SOLIDS COMBUSTION (3) Current approaches to heterogeneous reactions in combustion and gasification of coals and carbons. Prerequisite: Chem. 461. *Mr. Walker*
507. ADVANCED THERMAL PROCESSING (3) Pyrolysis, coal carbonization, coke manufacture and uses; action of heat on coals and fuels; technical and economic factors. Prerequisites: Chem. 35, 461, or Mn.Pr. 410. *Mr. Polansky*
509. TECHNOLOGY OF TARS (3) Formation, constitution, physical and chemical properties of coal, oil-gas and water-gas tar; processing and utilization. Prerequisite: Chem. 31. *Mr. Polansky*
510. FUEL TECHNOLOGY PROBLEM (1-6 per semester) Special problems in fuel technology. Prerequisite: F.T. 503.
511. FUEL TECHNOLOGY SEMINAR (1-6) Selected topics from current fuel technology research examined and discussed. Prerequisite: Chem. 35 or 461. *Mr. Kinney and Staff*
512. ADVANCED GASEOUS COMBUSTION (3) Theories of reaction mechanisms; measurement of gaseous combustion parameters; review of current literature. Prerequisite: F.T. 406. *Mr. Palmer*
- NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in fuel technology studies are listed under Mineral Sciences in Part II of this bulletin.

## GENERAL HOME ECONOMICS

DOROTHY HOUGHTON, *Professor of Home Economics*  
103 Home Economics Building

General home economics is an unusual major not found in most graduate schools. It is planned for teachers in secondary schools or small colleges and others who wish to be proficient in several areas of home economics. Consequently, the student must have a strong home economics background for admission to the major.

The major for the M.S. or M.Ed. degree consists of a minimum of 6 credits in each of three areas of home economics. Three areas of home economics are also the basis for the major at the doctoral level (Ph.D. or D.Ed.). However, the minimum credit requirements in each area are established after consultation with a committee which reviews all previous work.

The student chooses a minor field of basic education or one of the applied fields, such as home economics education, secondary education, or higher education.

## GENERAL HOME ECONOMICS

### GENERAL HOME ECONOMICS (G H E)

516, 516v. METHODS OF RESEARCH IN HOME ECONOMICS (3) Review of problems and techniques of research in home economics. Required of all graduate students in home economics. *Miss Hatcher*

530. SELECTED PROBLEMS IN GENERAL HOME ECONOMICS (1-6)

## GENETICS AND BREEDING

JAMES E. WRIGHT, *Chairman of the Committee on Genetics and Breeding*  
307 Buckhout Laboratory

The M.S. and Ph.D. degrees are offered in the fields of theoretical and applied genetics. Courses in genetics and breeding are given by various departments. The basic and theoretical courses are listed as identical numbers in the Department of Botany and Plant Pathology and the Department of Zoology and Entomology. Courses dealing with genetic principles as applied to specific organisms are offered in the Departments of Agronomy, Animal Husbandry, Bacteriology, Horticulture, and Poultry Husbandry. The graduate committee for majors shall be appropriately represented by members of theoretical and applied phases who shall have the responsibility and jurisdiction for determining course work and research acceptable in satisfying degree requirements.

Minimum requirements for entry as a major in this field shall consist of not less than 15 credits in basic biology and 15 credits in the areas of chemistry, mathematics, and physics.

The following courses are available in genetics and breeding, and their descriptions may be found under the offerings of the several departments: Agro. 411, 509, 510, 582; A.H. 501, 505; Bact. 516; Bot. or Zool. 405, 422, 505, 524, 528, 533; Hort. 444, 503, 519, 520; P.H. 412.

## GEOGRAPHY

E. WILLARD MILLER, *Head of the Department*  
202 Mineral Sciences Building

The department offers graduate work leading to the M.S., M.Ed., Ph.D., and D.Ed. degrees. Students may concentrate on cartography, physical geography, human geography, political geography, economic geography, or regional geography.

In order to enter graduate work, a student must qualify under one of two possible options: Option 1 requires that a student have completed as an undergraduate, with satisfactory grades, 18 credits in geography and 20 credits in mathematics and biological or physical sciences, including at least 6 credits in geology. Option 2 requires 18 undergraduate credits in geography plus 20 credits in the social sciences including at least 3 in economics.

### GEOGRAPHY (GEOG)

- 400. REGIONAL GEOGRAPHY OF NORTH AMERICA (3)
- 405. GEOGRAPHY OF POPULATION AND SETTLEMENT (3)
- 420. URBAN GEOGRAPHY (3)

*Mr. Deasy*  
*Mr. Rodgers*  
*Mr. Rodgers*

## GEOGRAPHY

- |                                                 |               |
|-------------------------------------------------|---------------|
| 427. REGIONAL GEOGRAPHY OF THE SOVIET UNION (3) | Mr. Rodgers   |
| 433. REGIONAL CLIMATOLOGY (3)                   | Mr. Wernstedt |
| 442. GEOGRAPHY OF EUROPE (3)                    | Mr. Miller    |
| 443. GEOGRAPHY OF THE ORIENT (3)                | Mr. Wernstedt |
| 444. GEOGRAPHY OF AFRICA (3)                    | Mrs. Greiss   |
| 452. INTERPRETATION OF AERIAL PHOTOGRAPHS (3)   | Mr. Deasy     |
| 460. POLITICAL GEOGRAPHY (3)                    | Mrs. Griess   |
| 480. GEOGRAPHY OF WORLD MANUFACTURING (3)       | Mr. Miller    |
| 490. PHYSICAL GEOGRAPHY FOR TEACHERS (3)        |               |
- 
503. **ADVANCED REGIONAL GEOGRAPHY (3-12)** Intensive study at an advanced level of selected regions or sections of the continents. Prerequisite: 12 credits in geography.
504. **PHYSICAL GEOGRAPHY SEMINAR (3-12)** The literature of some phase of physical geography with emphasis on procedures for organizing material for classroom reports and discussions.
505. **ECONOMIC GEOGRAPHY SEMINAR (3-12)** The literature of some phase of economic geography with emphasis on procedures for organizing material for classroom reports and discussions.
506. **CULTURAL AND POLITICAL GEOGRAPHY SEMINAR (3-12)** The literature of some phase of cultural and political geography with emphasis on procedures for organizing material for classroom reports and discussions.
507. **DEVELOPMENT OF GEOGRAPHIC THOUGHT (1-6)** Critical analysis of the growth of geographic thought from antiquity to the present; emphasis on structure of modern geography.
510. **PHYSICAL GEOGRAPHY RESEARCH (3-10)** Original study in physical geography: a field problem or detailed library investigation with analysis and presentation of data.
511. **ECONOMIC GEOGRAPHY RESEARCH (3-10)** Original study in economic geography: a field problem or detailed library investigation with analysis and presentation of data.
512. **CULTURAL AND POLITICAL GEOGRAPHY RESEARCH (3-10)** Original study in cultural and political geography: a field problem or detailed library investigation with analysis and presentation of data.

## GEOLOGY

FRANK M. SWARTZ, *Head of the Department*  
110 Mineral Sciences Building

Graduate work leading to the M.S. and Ph.D. degrees is offered with opportunity for specialization in stratigraphy, paleontology, paleobotany, palynology, regional and structural geology, geomorphology, coal geology, and metalliferous geology.

Prerequisites for admission to graduate standing include 25 semester hours in an approved combination of chemistry, physics, mathematics, and biological sciences, and at least 18 semester hours in geology and mineralogy.



## GEOLOGY

### GEOLOGY (GEOL)

400. GEOLOGY FOR TEACHERS (3)  
420. PALEOBOTANY (3) *Mr. Spackman*  
424. GEOLOGY OF COAL (2) *Mr. Nickelsen*  
426. INTRODUCTORY PALYNOLOGY (2) *Mr. Kremp*  
451. ECONOMIC GEOLOGY (3) *Mr. Burnham*  
455. PHYSIOGRAPHY OF NORTH AMERICA (3)  
461. GEOLOGY OF THE UNITED STATES (3) *Mr. Nickelsen*  
462. PRINCIPLES OF GEOMORPHOLOGY (3-6) *Mr. Lattman*  
464. PALEONTOLOGY (3) *Mr. Swartz*  
481. GEOLOGY OF OIL AND GAS (3) *Mr. Scholten*  
483. STRUCTURAL GEOLOGY (3) *Mr. Nickelsen*  
484. PALEOZOIC STRATIGRAPHY (3) *Mr. Swartz*  
486. STRATIGRAPHIC METHODS (1) *Mr. Swartz*
- \*500. GEOLOGY SEMINAR (1-9) Presentation, at weekly departmental meetings, of topics selected from geological literature.
- †501. STRATIGRAPHY (3-12) Principles of stratigraphic classification, lithofacies and biofacies, faunal zonation, correlation, sedimentation, and paleogeography, illustrated by stratigraphy of classical geologic regions: (a) Pre-Cambrian; (b) Paleozoic; (c) Mesozoic; (d) Cenozoic. Prerequisite: Geol. 464. *Mr. Swartz*
- †503. PALEONTOLOGY (3-9) Morphology of animal groups significant for their fossils; nature of species and faunal zones. Seminars may be arranged for studies of special fossil groups, microfossils, paleoecology. *Mr. Swartz*
504. HISTORY OF GEOLOGY (2-3) Development through the ages of the scientific method in earth sciences. Fall semester, odd years. *Mr. Krynine*
507. SEMINAR IN GEOMORPHOLOGY (3-6) Classic and current literature in geomorphology. *Mr. Lattman*
511. ORE DEPOSITS: PRINCIPLES (3-6) Geological and geochemical processes controlling ore deposition; genetic classification of ore deposits. Prerequisite: Geol. 451. *Mr. Ridge*
512. ORE DEPOSITS: TYPES (1-6) Geologic history and field examination of selected ore bodies; forming media; causes, sequences, and loci of emplacement; wall rock alteration; secondary enrichment. Prerequisite: Geol. 511. *Mr. Ridge*
515. ORE MICROSCOPY (2-3) Theory and use of the ore microscope in identifying ore minerals in polished section, establishing paragenetic sequences, determining manner of deposition. *Mr. Burnham*
520. SEMINAR IN PALEOBOTANY (2-6) Current and classic literature concerning evolution, paleoecology, and geologic history of vascular plants. *Mr. Spackman*
524. COAL PETROLOGY (1-6) Microscopy, source materials, coalification, constitution, classification of peats, lignites, bituminous coal, anthracite. *Mr. Spackman*

\* Credits to be arranged, 1 to 6 per semester.

† Credits to be arranged, 3 to 6 per semester.

526. PROBLEMS IN PALYNOLOGY (3-9) Systematics; paleoecological palynology; Paleozoic palynology; Mesozoic and Cenozoic palynology; Pleistocene vegetational history. *Mr. Kremp*
530. GEOLOGICAL PROBLEMS (3-6) Study, from the literature, of a selected geological problem. Prerequisite: 10 credits in geology and mineralogy.
545. GLACIAL GEOLOGY (3) Glaciers: their characteristics, causes, deposits, land forms, effects in periglacial regions. *Mr. Lattman*
546. PRINCIPLES OF PHOTOGEOLOGY (3) Use of aerial photographs and mosaics in structural, geomorphic, and rock distribution studies and in compilation of maps. Prerequisites: Geol. 462, 483. *Mr. Lattman*
551. GEOTECTONICS (3-6) Tectonic principles and elements: nature and development of geosynclines, island arcs, mountain structures, stable masses, cratons, mobile belts. *Mr. Scholten*
555. ADVANCED STRUCTURE AND PETROFABRICS (1-3) Macroscopic and microscopic recognition, measurement, and interpretation of small-scale rock structures and mineral orientation patterns in deformed rocks. *Mr. Nickelsen*
571. PETROLEUM PROVINCES OF THE WORLD (3) Stratigraphy, structure, geologic history, and oil and gas occurrence in major petroliferous provinces. *Mr. Scholten*
590. GEOLOGY FIELD TRIP (1 per year) Field study of regional geologic features with trips in successive years to differing geologic provinces. Required each spring of all graduate students in geology.

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in geological studies are listed under Mineral Sciences in Part II of this bulletin.

## GOPHYSICS AND GEOCHEMISTRY

B. F. HOWELL, JR., *Head of the Department*  
220 Mineral Sciences Building

The M.S. and Ph.D. degrees are offered in the field of geophysics (geophysical prospecting, seismology, gravity, well logging, radioactive age determinations, tectonics) and in the field of geochemistry (crystal chemistry, phase equilibria, element distribution and affiliations, isotope geochemistry, geochemical prospecting, cosmochemistry, high temperature and high pressure geochemistry).

For admission to graduate work in geophysics an applicant is generally expected to have had 10 semester hours of geology and mineralogy, 20 of physics and chemistry, and mathematics through differential equations; for geochemistry, 10 semester hours of geology and mineralogy, 24 of chemistry and physics, and mathematics through integral calculus. Students who have taken somewhat less than the indicated minima in these subjects may be admitted but must make up their deficiencies concurrently with their graduate studies.

### GOPHYSICS AND GEOCHEMISTRY (G G)

401. ELECTRICAL PROSPECTING (3)  
402. SEISMIC PROSPECTING (3)

*Mr. Howell*

## GEOPHYSICS AND GEOCHEMISTRY

403. GEOPHYSICS FIELD WORK (1-3)
405. INTRODUCTORY GEOPHYSICS (3) *Mr. Howell*
406. INTRODUCTORY GEOCHEMISTRY (3) *Mr. Keith*
407. WELL LOGGING (3)
408. POTENTIAL THEORY APPLIED TO EARTH PROBLEMS (3)
409. GEOPHYSICAL PROSPECTING (3)
500. GEOPHYSICAL SEMINAR (1 per semester) Discussion of geophysical reports and papers; scientific outlook. Prerequisites: G.G. 401, 402. *Mr. Howell*
501. RESEARCH (1-15 per semester) Original research in geophysics or geochemistry.
502. SEISMIC INSTRUMENTS (3) Characteristics and design of seismometers and seismic recorders. Prerequisite: Phys. 285, differential equations. Given alternate years. *Mr. Howell*
503. SPECIAL STUDIES IN GEOPHYSICS (1-9) Special studies of the theories of geophysical methods. Prerequisite: 6 credits in geophysics.
507. SEISMOLOGY (3) Nature and transmission of seismic waves; cause and occurrence of earthquakes; applications in seismic prospecting. Prerequisites: Math. 44, Phys. 285. *Mr. Howell*
508. TECTONICS (3) Seminar in the cause and nature of the principal deformations of the earth. Prerequisite: Geol. 483. *Mr. Howell*
509. GEOCHEMISTRY SEMINAR (1 per semester)
510. PROBLEMS IN GEOCHEMISTRY (1-9) Laboratory and library study of special problems. Prerequisite: G.G. 406.
512. INTRODUCTION TO HIGH-TEMPERATURE GEOCHEMISTRY (3) Ion configuration and radii; simple crystal structures; measurement and control of temperature and pressure; methods and principles of phase equilibrium determination. *Messrs. Roy and Osborn*
513. PHASE EQUILIBRIA IN MINERAL SYSTEMS (3-6) Phase relations and constitution of inorganic crystals and liquids; special emphasis on systems closely related to natural magmas and rock systems. Prerequisite: G.G. 512. *Messrs. Osborn, Tuttle, and Roy*
514. ELEMENT DISTRIBUTION IN THE EARTH (3) Principles and data from studies of phase equilibria, petrology, and crystal structure as related to distribution of elements in minerals, rocks, and the earth. *Mr. Herzog*
515. ELECTRIC WELL-LOGGING (2-3) Quantitative and qualitative methods of interpreting electric resistivity, induction, and self-potential logs; comparison of electrical logging methods. Prerequisites: Phys. 285, Math. 43.
516. NUCLEAR GEOPHYSICS (3) Natural radioactivity and its measurement, spectroscopy, age determinations, geothermometry, radioactive prospecting and logging.
- NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in geophysical and geochemical studies are listed under Mineral Sciences in Part II of this bulletin.



## GERMAN

PHILIP A. SHELLEY, *Head of the Department*  
229 Sparks Building

Graduate study in German may lead to the M.A., M.Ed., or Ph.D. degree. There is opportunity for major emphasis upon either literature or philology. Minimum qualifications for admission include 18 undergraduate credits in German; provision is made, however, for admission with limited deficiencies.

## GERMAN (GER)

- |                                                                                                                                                                               |                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| 400. PROSEMINAR IN BIBLIOGRAPHY AND METHODS OF RESEARCH (2)                                                                                                                   | <i>Mr. Shelley</i>    |
| 401. HISTORY OF THE GERMAN LANGUAGE (3)                                                                                                                                       | <i>Mr. Buffington</i> |
| 402. MIDDLE HIGH GERMAN (3)                                                                                                                                                   | <i>Mr. Buffington</i> |
| 420. GERMAN LITERATURE TO 1700 (3)                                                                                                                                            | <i>Miss Adolf</i>     |
| 421. GERMAN LITERATURE IN THE 18TH CENTURY (3)                                                                                                                                | <i>Mr. Buffington</i> |
| 422. GERMAN LITERATURE IN THE 19TH CENTURY (3)                                                                                                                                | <i>Miss Adolf</i>     |
| 423. GERMAN LITERATURE OF THE 20TH CENTURY (3)                                                                                                                                |                       |
| 424. GOETHE'S LIFE AND WORKS (3)                                                                                                                                              | <i>Mr. Buffington</i> |
| 426. SCHILLER'S LIFE AND WORKS (3)                                                                                                                                            |                       |
| 443. (C.Lit. 443). LITERARY RELATIONS OF GERMANY WITH ENGLAND AND AMERICA (3-9)                                                                                               | <i>Mr. Shelley</i>    |
| *1G. ELEMENTARY GERMAN FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.                                       |                       |
| *2G. ELEMENTARY GERMAN FOR GRADUATE STUDENTS (3) Continuation of Ger. 1G, with opportunity for reading in special fields.                                                     |                       |
| 501. GERMAN LANGUAGE SEMINAR (3-12) Critical study of special problems in the Germanic languages, with emphasis on Gothic and the High German dialects in different eras.     |                       |
| 515. GERMAN LITERATURE SEMINAR (3-12) Special aspects and characteristics of individual writers and various types and periods of literature.                                  |                       |
| 531. SPECIAL STUDIES IN THE GERMAN LYRIC (3)                                                                                                                                  | <i>Mr. Shelley</i>    |
| 532. SPECIAL STUDIES IN THE GERMAN DRAMA (3)                                                                                                                                  | <i>Miss Adolf</i>     |
| 533. SPECIAL STUDIES IN THE GERMAN SHORT STORY (3)                                                                                                                            |                       |
| 534. SPECIAL STUDIES IN THE GERMAN NOVEL (3)                                                                                                                                  | <i>Miss Adolf</i>     |
| 552. OLD HIGH GERMAN (3) Essentials of the grammar, with special treatment of the High German sound shift and of ablaut and umlaut. Reading of works written before 1100 A.D. | <i>Mr. Buffington</i> |
| 553. GOTHIC (3) Essentials of the grammar; reading of Ulfilas' Bible translation. Suitable also for advanced students in English.                                             | <i>Miss Adolf</i>     |

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\* No graduate credit is given for this course.

## HISTORY

JOSEPH G. RAYBACK, *Head of the Department*  
116 Sparks Building

Graduate programs are offered leading to the M.A., M.Ed., Ph.D., and D.Ed. degrees. The student may specialize in medieval history, early modern European history, modern European history, colonial American history, 19th Century American history, modern American history, or Latin-American history.

The entering student should present evidence of undergraduate course work covering the history of Europe from ancient times to the present and the history of America from its discovery to the present.

## HISTORY (HIST)

- |                                                                         |                            |
|-------------------------------------------------------------------------|----------------------------|
| 401. ANCIENT CIVILIZATION (3)                                           |                            |
| 403. THE MIDDLE AGES FROM CONSTANTINE TO THE CRUSADES (3)               | Mr. Dahmus                 |
| 404. THE MIDDLE AGES FROM THE CRUSADES TO THE RENAISSANCE (3)           | Mr. Dahmus                 |
| 408. INTELLECTUAL HISTORY OF THE MIDDLE AGES (2-3)                      | Mr. Dahmus                 |
| 410. RENAISSANCE AND REFORMATION (3)                                    | Mr. Green                  |
| 413. THE AGE OF ABSOLUTISM (3)                                          | Mr. Green                  |
| 417. NINETEENTH CENTURY EUROPE (3)                                      | Mr. Forster                |
| 419. RECENT EUROPEAN HISTORY (3)                                        | Mr. Forster                |
| 420. COLONIAL AMERICA, 1607-1750 (3)                                    | Mr. Hanna                  |
| 422. HISTORY OF THE AMERICAN FRONTIER (3)                               | Mr. Spence                 |
| 424. AMERICAN POLITICAL BIOGRAPHY (3)                                   | Messrs. Klein and Murray   |
| 425. HISTORICAL BACKGROUND OF AMERICAN POLITICAL PARTIES, 1607-1900 (3) | Mr. Rayback                |
| 427. THE DIPLOMATIC HISTORY OF THE UNITED STATES (3)                    | Mr. DeNovo                 |
| 428. AMERICAN MILITARY HISTORY (3)                                      | Mr. Hassler                |
| 431. THE AMERICAN REVOLUTION, 1751-1783 (3)                             | Mr. Colbourn               |
| 432. THE FORMATIVE PERIOD OF AMERICAN HISTORY (3)                       | Messrs. Klein and Colbourn |
| 436. RECENT AMERICAN HISTORY (3)                                        | Mr. Murray                 |
| 440. HISTORY OF ENGLAND AND GREAT BRITAIN SINCE 1485 (3)                |                            |
| 442. HISTORY OF RUSSIA TO 1861 (3)                                      | Mr. Thaden                 |
| 443. HISTORY OF MODERN RUSSIA (3)                                       | Mr. Thaden                 |
| 444. EASTERN EUROPE IN MODERN TIMES (3)                                 | Mr. Thaden                 |
| 447. ECONOMIC DEVELOPMENT OF MODERN EUROPE (3)                          | Mr. Pundt                  |
| 448. SOCIAL AND CULTURAL HISTORY OF MODERN EUROPE (3)                   | Mr. Pundt                  |
| 452. SOCIAL AND CULTURAL HISTORY OF THE UNITED STATES SINCE 1783 (3)    | Mr. Brown                  |
| 454. ECONOMIC DEVELOPMENT OF THE UNITED STATES (3)                      | Mr. McNall                 |
| 456. HISTORY OF AMERICAN LABOR (3)                                      | Mr. Rayback                |
| 460. LATIN AMERICA AND THE UNITED STATES (3)                            | Mr. Gray                   |
| 461. SOCIAL AND CULTURAL HISTORY OF LATIN AMERICA (3)                   | Mr. Gray                   |
| 481. THE MIDDLE EAST IN MODERN TIMES (3)                                | Mr. DeNovo                 |
| 499. FOREIGN STUDY IN HISTORY (2-6)                                     |                            |
| 501. EUROPEAN HISTORIOGRAPHY (3)                                        | Mr. Pundt                  |
| 502. AMERICAN HISTORIOGRAPHY (3)                                        | Mr. Klein                  |
| 504. MEDIEVAL CIVILIZATION (3-9)                                        | Mr. Dahmus                 |
| 505. THE AGE OF THE REFORMATION (3-6)                                   | Mr. Green                  |

## HISTORY

508. STUDIES IN EUROPEAN HISTORY, 1600-1789 (3-6) *Mr. Pundt*
509. EUROPE SINCE 1789 (3-6) Prerequisites: Hist. 18, 19. *Mr. Forster*
512. STUDIES IN PENNSYLVANIA HISTORY (3-6) *Mr. Klein*
520. COLONIAL AND REVOLUTIONARY AMERICA (3-6) Prerequisites: Hist. 20, 21. *Mr. Colbourn*
533. THE UNITED STATES, 1783-1860 (3-6) *Mr. Klein*
534. THE UNITED STATES, 1860-1900 (3-6) Prerequisites: Hist. 20, 21. *Mr. Brown*
536. THE UNITED STATES IN THE 20TH CENTURY (3-6) *Mr. Murray*
538. DIPLOMATIC HISTORY OF THE UNITED STATES (3) *Messrs. Gray and DeNovo*
539. ECONOMIC HISTORY OF THE UNITED STATES (3) *Mr. McNall*
540. STUDIES IN BRITISH HISTORY (3-6)
550. PROBLEMS IN HISTORY (3-6)
562. SEMINAR IN LATIN-AMERICAN HISTORY (3-6) Prerequisites: Hist. 22, 23. *Mr. Gray*
563. STUDIES IN THE HISTORY OF THE CARIBBEAN AREA (3) Prerequisites: Hist. 22, 23. *Mr. Gray*

## HOME ART

No advanced degree is offered in this field, but a candidate with a major in another field may choose a minor in home art upon approval by his major department.

### HOME ART (H ART)

400. SPECIAL PROBLEMS IN HOME FURNISHINGS (3)
433. ADVANCED HOME CRAFTS (2-12)
434. THE ART AND THE CRAFTS IN THE HOMEMAKING PROGRAM (3-6)
440. HOME FURNISHING PROBLEMS (3)
443. HOME ARTS IN THE ADULT PROGRAM (3)
444. HOME FURNISHING TEACHING PROBLEMS (3)
447. HOME FURNISHINGS FOR THE FAMILY (3)
515. BACKGROUNDS OF THE HOME ARTS (3) Evaluation of useful objects in respect to their form, function, and time; selections for exhibition. Prerequisites: H.Art 216 or Art 15 or A.Ed. 6, and A.A.H. 1 or H.Art 240.
530. PROBLEMS IN HOME ART (1-6) Individual investigation, analysis, and presentation. Prerequisite: 6 credits in home art, art education, or art.
541. ART IN THE ENVIRONMENT (3) Approach based upon human needs with consideration of materials in the light of their use in home living. Prerequisite: Art 14 or A.Ed. 5 or H.Art 440.



## HOME ECONOMICS EDUCATION

MARJORIE EAST, *Head of the Department*  
119C Home Economics Building

The department offers graduate work leading to the M.S., M.Ed., Ph.D., and D.Ed. degrees. Research and graduate courses may be chosen to give emphasis to special areas of interest in home economics education, such as curriculum development; evaluation; teaching at the elementary, secondary, adult, or higher education levels; supervision; administration in colleges; or research.

The student wishing to study for a graduate degree in this field should present approximately 50 semester hours of undergraduate work from the following areas: home economics education, education and/or psychology, aspects of home economics; the physical and biological sciences; and the social sciences.

### HOME ECONOMICS EDUCATION (HE ED)

406, 406v. TEACHING AIDS IN FAMILY LIFE EDUCATION (1-4)

427, 427v. FAMILY LIFE EDUCATION (3)

443, 443v. ADULT HOMEMAKING EDUCATION (3)

463, 463v. SENIOR SEMINAR (1)

\*466, 466v. STUDENT TEACHING (9)

478, 478v. APPRAISING STUDENT PROGRESS IN EDUCATION FOR FAMILY LIVING (3)

479, 479v. READINGS IN HOME ECONOMICS EDUCATION (1-4)

502, 502v. HOME ECONOMICS INSTRUCTION AT THE COLLEGE LEVEL (3) Teaching techniques suitable for college instruction in home economics; for prospective home economics college teachers not majoring in home economics education.

503, 503v. PROBLEMS IN HOME ECONOMICS TEACHER EDUCATION (3) Organization of college programs of teacher education; use of resources; records; field services; recruitment and selection of personnel. Prerequisite: at least two years of experience in teaching home economics.

504, 504v. CURRENT DEVELOPMENTS IN EDUCATION IN RELATION TO HOME ECONOMICS (3) Opportunity for home economists to study newer developments in education. Prerequisite: one year of teaching experience in home economics. *Mrs. East*

505, 505v. PRACTICUM IN TEACHING HOME ECONOMICS IN THE SECONDARY SCHOOL (3-6) Projects in home economics education which may be carried out in the school in which the teacher is regularly employed. *Miss Hillier*

509, 509v. CURRICULUM WORKSHOP IN FAMILY LIFE EDUCATION (3) Laboratory course in problems of curriculum building; individual problems in this field; frequent individual and group conferences. Prerequisite: one year's experience in teaching home economics. *Mrs. East, Miss Hatcher, or Miss Hillier*

510, 510v. THE SUPERVISION OF HOME ECONOMICS TEACHING (2-6) For teachers of home economics desiring to qualify as city, county, or student teacher supervisors. Prerequisite: graduation from a four-year teacher education curriculum and two years' teaching experience in home economics. *Mrs. East or Miss Hillier*

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\* A grade point average of 2.2 in all previous work is prerequisite to each course in student teaching.

## HOME ECONOMICS EDUCATION

- 518, 518v. EVALUATION IN FAMILY LIFE EDUCATION (3) Methods of evaluating progress toward goals in home economics education and use of findings in program planning and revision. *Mrs. East, Miss Hatcher, or Miss Hillier*
- 521, 521v. HOME ECONOMICS EDUCATION SEMINAR (2-3) Selected topics and recent developments in education for family living. Conferences and guidance relative to individual research problems. *Mrs. East or Miss Hatcher*
- 526, 526v. THE COMMUNITY PROGRAM IN FAMILY LIFE EDUCATION (2-3) Ways of discovering community needs and resources; methods of developing the community program in family living; leadership education for the lay member of the community.
- 530, 530v. PROBLEMS IN HOME ECONOMICS EDUCATION (1-6 per semester) Individual investigation of problems related to the teaching, supervision, or administration of home economics education.

## HOME MANAGEMENT AND FAMILY ECONOMICS

DELPHA E. WIESENDANGER

*Head of the Department of Home Management, Housing, and Home Art*  
109A Home Economics Building

The M.Ed., M.S., D.Ed., and Ph.D. degrees are offered with a major in home management and family economics. Family management practices, their effects upon members of the family unit, and the interaction of such practices with the local and national economy are studied in relation to principles of economics, philosophy, psychology, sociology, and political science.

Those interested in emphasizing a study of home management, family economics, family housing, and home equipment may do so through this major. There are no specific course requirements for admission.

### HOUSING AND HOME EQUIPMENT (HS EQ)

413. HOME EQUIPMENT (3)  
470. HOUSING THE FAMILY (2-3)

### HOME MANAGEMENT AND FAMILY ECONOMICS (HM FE)

415. HOUSEHOLD BUYING PRACTICES (3)  
419. MANAGING FAMILY FINANCIAL RESOURCES (3) *Mrs. Honey*  
423. (F.N. 423). FAMILY FOOD PURCHASING (2)  
424. ECONOMIC CONDITIONS IN RELATION TO THE FAMILY (3) *Miss Britton*  
439. HOME MANAGEMENT (2) *Miss Chennault*  
442. RESIDENT EXPERIENCE IN HOME MANAGEMENT (3) Room and board will be charged at regular rates. *Miss Starr and Miss Chennault*  
445. HOME MANAGEMENT EXPERIENCE (3) *Miss Starr*  
477. FAMILY MANAGEMENT (3)
515. CONSUMER PROBLEMS (2-3) Methods of securing, evaluating, and presenting data concerning household commodities. For home economics teachers in high schools, colleges, and adult classes. Prerequisites: F.N. 220, H.M.F.E. 442. *Miss Britton*

## HOME MANAGEMENT AND FAMILY ECONOMICS

524. ECONOMIC PROBLEMS OF THE HOUSEHOLD (3) Economic problems of the present-day family; special emphasis on factors in household production, use of money income, and standards of living. Prerequisites: H.M.F.E. 439, Econ. 14.  
*Miss Britton*
528. HOME MANAGEMENT SUPERVISION (2-3) Evaluation of objectives and techniques in organization, supervision, and teaching of the home management house experience. Prerequisite: H.M.F.E. 439.
543. HOME MANAGEMENT IN RELATION TO FAMILY LIVING (3) Includes work with families in solution of their management problems. Prerequisites: F.N. 220, H.M.F.E. 439.  
*Miss Wiesendanger*
544. PROBLEMS IN HOME MANAGEMENT AND FAMILY ECONOMICS (1-6) Investigation of selected problems in home management and family economics. Prerequisite: 6 credits of home management or family economics courses in home economics.
550. SEMINAR IN HOME MANAGEMENT AND FAMILY ECONOMICS (1-6) Discussion and reports on developments in home management and family economics.

## HORTICULTURE

RUSSELL E. LARSON, *Head of the Department*  
102 Tyson Building

The department offers major work for the M.S. and Ph.D. degrees with specialization in propagation, production, processing, breeding, nutrition, and other physiological studies of horticultural crop species. Students may also specialize in the field of landscape design.

Prerequisites for major work in horticulture vary according to area of specialization; but basic courses in chemistry, mathematics, and the biological sciences are required. Prerequisites for advanced work in landscape architecture include basic courses in art, architecture, chemistry, mathematics, biological sciences, and 30 or more semester hours in landscape architecture. Students who lack prerequisite courses may be admitted but are required to fulfill deficiencies without degree credit.

### HORTICULTURE (HORT)

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|-----------------------------------------------------|--------------------|
| 412. STORAGE OF HORTICULTURAL CROPS (3)             | <i>Mr. Ritter</i>  |
| 418. SUBTROPICAL AND TROPICAL FRUITS (3)            |                    |
| 420. ADVANCED COMMERCIAL VEGETABLE PRODUCTION (3)   | <i>Mr. Odland</i>  |
| 424. ADVANCED OLERICULTURE (3-6)                    | <i>Mr. Odland</i>  |
| 425. ADVANCED FRUIT AND VEGETABLE PROCESSING I (3)  |                    |
| 426. ADVANCED FRUIT AND VEGETABLE PROCESSING II (3) |                    |
| 427. ADVANCED FLORICULTURE (3)                      | <i>Mr. Boodley</i> |
| 428. ADVANCED FLORICULTURE (3)                      | <i>Mr. Boodley</i> |
| 444. ADVANCED PLANT BREEDING (3-6)                  | <i>Mr. Walker</i>  |
| 446. ADVANCED POMOLOGY (3)                          |                    |
| 447. PROBLEMS IN HORTICULTURE (1-6)                 |                    |
| 453. NURSERY PRINCIPLES AND PRACTICE (3)            | <i>Mr. Meahl</i>   |
| 456. PROBLEMS IN NURSERY PRACTICE (3)               | <i>Mr. Meahl</i>   |



500. **ECOLOGY OF FRUIT PLANTS (3)** Factors limiting the distribution and intensity of culture of fruit species and varieties and effect of environmental factors on cultural practices.
501. **EXPERIMENTAL PROBLEMS IN POMOLOGY (2-12)** Investigation of problems involving review of literature, field and laboratory research.
503. **EXPERIMENTAL PLANT BREEDING (2-12)** Problems based mainly on research work of the department, with review of experimental methods and literature. Prerequisite: Hort. 444. *Mr. Larson*
504. **EXPERIMENTAL PROBLEMS IN OLERICULTURE (2-9)** Investigation of problems involving review of literature, field and laboratory research. Prerequisite: Hort. 420 or 424. *Mr. Odland*
505. **PROBLEMS IN VEGETABLE PRODUCTION (2-6)** Methods used in the more valuable contributions to vegetable production. Prerequisite: Hort. 420 or 424. *Mr. Odland*
506. **NUTRITION OF HORTICULTURAL CROPS (2-4)** Principles, applications, and interpretations of diagnostic methods for determining fertilizer requirements of horticultural crops. *Mr. Smith*
512. **PRINCIPLES OF FRUIT AND VEGETABLE STORAGE (2-4)** Principles involved in the maturation, storage, and senescence of fruits and vegetables, and their application. *Mr. Ritter*
513. **EXPERIMENTAL PROBLEMS IN ORNAMENTAL HORTICULTURE (2-12)** Review of research in ornamental horticulture, with original investigations. *Mr. Meahl*
514. **PROPAGATION OF ORNAMENTAL AND FRUIT PLANTS (3)** Factors affecting the asexual and sexual propagation of fruit and ornamental plants. *Mr. Meahl*
517. **HORTICULTURE SEMINAR (1 per semester)** Review of current research publications in horticulture. Each student presents one or more reviews of assigned topics.
519. **SEMINAR ON THE GENETICS OF HORTICULTURAL CROPS (1 per semester)** Review of current research publications on the genetics of horticultural crops. Each student presents one or more reviews of literature on assigned topics.
520. **SEMINAR ON THE BREEDING OF HORTICULTURAL CROPS (1 per semester)** Each student presents one or more reviews of literature on assigned topics.
523. **PROPAGATION AND IMPROVEMENT OF VEGETABLE AND FLOWER CROPS (3)** Methods and special techniques in breeding of flowers and vegetables; maintenance of seed stocks and seed production. Prerequisite: Hort. 444. *Mr. Odland*
524. **EXPERIMENTAL PROCEDURES IN HORTICULTURAL RESEARCH (3)** *Mr. Larson*
525. **HORTICULTURAL RESEARCH TECHNIQUES (3)** Practice in and comparison of methods and apparatus used in horticultural research.
526. **EXPERIMENTAL PROBLEMS IN FLORICULTURE (2-12)** Greenhouse research and review of literature. Prerequisite or concurrent: Hort. 427, 428. *Mr. Mastalerz*
527. **EXPERIMENTAL PROBLEMS IN NUTRITION OF HORTICULTURAL CROPS (2-12)** Review of current research; problems for independent investigation. *Mr. Smith*
528. **PROBLEMS IN FRUIT AND VEGETABLE PROCESSING (2-12)**

## HORTICULTURE

### LANDSCAPE ARCHITECTURE (L ARCH)

434. (Rc.Ed. 434). RECREATION AREAS AND FACILITIES (3) *Mr. Wilson*  
454-455. LANDSCAPE DESIGN (4 each)  
460. ADVANCED LANDSCAPE DESIGN (3-6)  
461. PARK DESIGN AND ADMINISTRATION (3-6) *Mr. Wilson*  
462. SITE PLANNING OF INSTITUTIONAL AND PUBLIC PROJECTS (3-6) *Mr. Wilson*  
463. ADVANCED LANDSCAPE DESIGN (1-6)  
  
518. ADVANCED PROBLEMS IN LANDSCAPE DESIGN (2-12) Selected problems for original investigation in the design, construction, and maintenance of landscape architectural projects. Prerequisite: L.Arch. 455.  
  
521. TECHNICAL LANDSCAPE ARCHITECTURAL PRACTICES (2-12) Specific technical and professional problems in landscape architectural planning and practice. Prerequisites: L.Arch. 460, 461.

## INDUSTRIAL EDUCATION

S. LEWIS LAND, *Head of the Department*  
301 Burrowes Building

Graduate work in this department may lead to the M.Ed., M.S., D.Ed., or Ph.D. degree with majors in industrial arts education and vocational industrial education. Emphasis may be placed on improved teaching, supervision and administration, or preparation for teacher education.

The minimum undergraduate preparation includes graduation from an approved curriculum in the major area.

### INDUSTRIAL ARTS (I ART)

400. SHOP MANAGEMENT AND LAYOUT (3)  
407. INDUSTRIAL ARTS EDUCATION (3)  
421. CURRICULUM MATERIALS IN INDUSTRIAL ARTS (3)  
470. PROBLEMS IN SENIOR HIGH SCHOOL INDUSTRIAL ARTS (3)  
  
574. HISTORY AND PHILOSOPHY OF INDUSTRIAL ARTS (3) Historical developments and concurrent educational philosophies of industrial arts in American education. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.  
  
575. PROBLEMS IN INDUSTRIAL ARTS EDUCATION (3) Subject matter, projects, methods of manual and informational teaching, aids and devices, selection of text and reference materials, personnel organization, shop management, problem pupils. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.  
  
576. SUPERVISION AND ADMINISTRATION OF INDUSTRIAL ARTS EDUCATION (3) How to organize, supervise, and administer functioning programs of industrial arts; duties of a supervisor and director of industrial arts. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.  
  
577. TESTING IN INDUSTRIAL ARTS (3) Construction of informal manipulative and written tests; use of standardized mechanical aptitude and achievement tests; construction and use of rating scales; scoring and grading; interpretation of test re-

## INDUSTRIAL EDUCATION

sults. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.

578. RESEARCH IN INDUSTRIAL ARTS (3) Research techniques in industrial arts education. Prerequisite: 6 credits in professional courses in industrial arts.

580. SEMINAR IN INDUSTRIAL ARTS (9) Directed intensive study, investigation, or research in selected phases of the program; reports and constructive criticism. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.

### INDUSTRIAL EDUCATION (I ED)

402v. SUPERVISION OF VOCATIONAL EDUCATION (3)

403v. SUPERVISED FIELD WORK (6)

408v. OCCUPATIONS (3)

409v. TESTS AND MEASUREMENTS (3)

412v. SPECIAL PROBLEMS IN VOCATIONAL EDUCATION (4)

415v. PROBLEMS IN CO-ORDINATING VOCATIONAL EDUCATION (3)

420v. OCCUPATIONAL HYGIENE (3)

427v. ADVANCED COURSE OF STUDY BUILDING (3)

446v. IMPROVEMENT OF INSTRUCTION IN VOCATIONAL EDUCATION (4)

450v. SHOP LAYOUT AND MANAGEMENT (3)

460. PROBLEMS IN VOCATIONAL REHABILITATION OF THE HANDICAPPED (3 per unit)

*Unit A. The Counseling Interview in Vocational Rehabilitation (3)*

*Unit B. Occupational Information and Placement Techniques in Vocational Rehabilitation (3)*

501v. SEMINAR IN VOCATIONAL EDUCATION (12) Conferences, investigations, and discussion for advanced students and mature persons who have had experience as teachers, supervisors, or administrators.

506v. ADMINISTRATION OF VOCATIONAL EDUCATION (6) The job of the local director of industrial education in organizing and developing city and other local programs of industrial education. Prerequisite: 6 credits in industrial education or valid director's certificate, equivalent training and experience.

510v. VOCATIONAL EDUCATION FOR ADMINISTRATORS (3) Designed for school administrators and supervisors who desire an understanding of practical arts and vocational education. Prerequisite: I.Ed. 1v or trade or teaching experience.

550v. RESEARCH IN VOCATIONAL EDUCATION (3) Research techniques in vocational industrial education.

555v. CURRENT PROBLEMS IN VOCATIONAL EDUCATION (1 per unit) Recent trends and developments in part-time, full-time, and evening school education, involving critical analysis of objectives, content, and outcome.

*Unit A. Changing Industrial, Economic, and Social Conditions (1)*

*Unit B. Policies and Program of the American Vocational Association (1)*

*Unit C. Federal and State Vocational Legislation, Present and Pending (1)*

*Unit D. Financing Vocational Education (1)*

*Unit E. Current Administrative Problems in Vocational Education (1)*

*Unit F. Current Administrative Problems in Vocational Education (cont'd) (1)*



## INDUSTRIAL EDUCATION

### 558v. FRONTIER PROBLEMS IN VOCATIONAL INDUSTRIAL EDUCATION (3 per unit)

*Unit A. Federal Legislation* (3) Recent federal legislative activities and executive orders that bear directly and indirectly upon industrial education.

*Unit B. Present-Day Local, Personnel, and Curriculum Problems* (3) Various plans, techniques, and practices.

*Unit C. State and Local Supervision and Administration* (3) The more important recent problems in organization, supervision, and administration.

### 560v. PHILOSOPHY OF INDUSTRIAL EDUCATION (3) Principles and beliefs of progressive industrial education; literature for evaluating instructional practices. Prerequisite: 12 credits in industrial education or teaching experience.

## INDUSTRIAL ENGINEERING

BENJAMIN W. NIEBEL, *Head of the Department*  
203 Engineering C

The department offers graduate work leading to the M.S. degree. Graduate study and research are conducted in operations research, linear programming, queueing theory, and experimental design. Opportunities also exist for advanced study in automation, production engineering, product design for production, work measurement, costs and budgets, tool design, methods analysis, personnel management, and management controls.

In order to be admitted to graduate work in this field, the student must have been graduated from an accredited school with a major in industrial engineering. Graduates of other accredited engineering curriculums may be admitted after completing 27 credits in industrial engineering.

### INDUSTRIAL ENGINEERING (I E)

- |                                                                                                                                                               |                                                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|
| 400. ENGINEERING FOR PRODUCTION (3)                                                                                                                           | <i>Mr. Niebel</i>                                 |
| 402. ENGINEERING ECONOMY (3)                                                                                                                                  | <i>Messrs. Niebel, Roscoe, and Thuering</i>       |
| 404. SCIENTIFIC MANAGEMENT (2)                                                                                                                                | <i>Messrs. Caldwell and Roscoe</i>                |
| 406. FACTORY PLANNING (2)                                                                                                                                     | <i>Messrs. Thuering and Linsky</i>                |
| 422a,b,c,d,e,f. INDUSTRIAL ENGINEERING PROBLEMS (2-12)                                                                                                        | <i>Messrs. Niebel, Thuering, Linsky, and Moss</i> |
| 423. QUALITY CONTROL (2)                                                                                                                                      | <i>Mr. Thuering</i>                               |
| 424. JOB EVALUATION (3)                                                                                                                                       | <i>Mr. Farwell</i>                                |
| 425. METHODS OF INDUSTRIAL OPERATIONS RESEARCH (3)                                                                                                            |                                                   |
| 426. INDUSTRIAL AUTOMATION (3)                                                                                                                                | <i>Mr. Linsky</i>                                 |
| 429. PLASTIC WORKING OF METALS (3)                                                                                                                            | <i>Mr. Roscoe</i>                                 |
| 430. INDUSTRIAL LEADERSHIP (3)                                                                                                                                | <i>Mr. Caldwell</i>                               |
| 432. INDUSTRIAL ENGINEERING LECTURES (1-3)                                                                                                                    |                                                   |
| 501. MANUFACTURING METHODS (2-8) Special projects including investigation; experimentation, design, and research of one or more special types of manufacture. | <i>Messrs. Niebel and Thuering</i>                |
| 502. MANAGEMENT METHODS (3-6) Scientific management, including management controls and mathematical programming; research on special problems.                | <i>Mr. Thuering</i>                               |
| 503. PERSONNEL RELATIONS (2-8) Research on special topics.                                                                                                    | <i>Mr. Williamson</i>                             |

## INDUSTRIAL ENGINEERING

505. GRAPHICAL COMPUTATION (2-6) Construction of natural and logarithmic scales, applications of various co-ordinate papers and construction of nomographic or alignment charts; determination of empirical formulae from engineering data.

*Mr. Thuerling*

506. TIME AND MOTION STUDY (3-9) Methods of research in motion and time study; critical analysis of current literature.

507. BUDGETARY CONTROL AND STANDARD COSTS (3-6) Divisional budgets as control media; establishing standard cost data, standard cost accounting procedures, and use of cost variances in controlling manufacturing operations. Prerequisite: I.E. 335.

513. DATA PROCESSING AND PROGRAMMING (3) Theory and techniques in systems analyses applied to the programming of procedures and operations.

## INSTITUTION ADMINISTRATION

ESTHER A. ATKINSON

*Professor of Hotel and Institution Administration*

4D Home Economics Building

The Department of Hotel and Institution Administration offers graduate work leading to the M.S. degree in institution administration. Prerequisite to graduate work is the completion of the following undergraduate work: 12 credits in the physical and biological sciences, 9 in the social sciences, 6 in foods and nutrition, and 9 in institution administration including one course in quantity food preparation.

### HOTEL ADMINISTRATION (H A)

440. HOTEL OPERATIONAL LIABILITIES (2)

445. HOTEL ORGANIZATION AND OPERATION (3)

### INSTITUTION ADMINISTRATION (IN A)

410. TEA ROOM MANAGEMENT (3)

437. SCHOOL CAFETERIA PROBLEMS (1 per unit)

*Unit A. Nutrition and Menu Planning (1)*

*Unit B. Equipment (1)*

*Unit C. Organization and Management (1)*

438. SCHOOL LUNCH ADMINISTRATION (3)

461. INSTITUTION ADMINISTRATION (3)

462. INSTITUTION EXPERIENCE (3)

502. PROBLEMS IN INSTITUTIONAL ADMINISTRATION (3-6) Individual study of problems in institutional administration. Prerequisites: In.A. 326, 330. *Miss Atkinson*

## JOURNALISM

JAMES W. MARKHAM, *Chairman of the Graduate Program*

115 Carnegie Building

The School of Journalism offers graduate work leading to the M.A. degree in journalism with concentration on either editorial journalism or advertising.

## JOURNALISM

The entering student should present the equivalent of an undergraduate major in journalism. Lacking this, he may make up the deficiency by completing basic undergraduate courses specified by the School. Up to 18 credits may be required. The deficiency also may be made up by submission of evidence of adequate professional experience in journalism, or by completion of examinations testing the student's knowledge of journalism fundamentals.

### JOURNALISM (JOURN)

- |                                                            |                                |
|------------------------------------------------------------|--------------------------------|
| 401. THE PRESS, ITS CRITICS AND ETHICS (2)                 | <i>Mr. Dennis</i>              |
| 405. COMPARATIVE FOREIGN JOURNALISM (2)                    | <i>Mr. Markham</i>             |
| 424. PUBLIC AFFAIRS REPORTING (3)                          | <i>Mr. Marbut</i>              |
| 430. SUPERVISION AND MANAGEMENT OF SCHOOL PUBLICATIONS (3) | <i>Mr. Vairo</i>               |
| 441. ADVANCED ADVERTISING COPYWRITING (3)                  | <i>Messrs. Davis and Hicks</i> |
| 443. ADVERTISING CAMPAIGNS (3)                             | <i>Mr. Davis</i>               |
| 466. PUBLICITY AND PUBLIC RELATIONS PROBLEMS (3)           | <i>Mr. Markham</i>             |
| 468. LAW OF MASS COMMUNICATIONS (3)                        |                                |
| 480. PROBLEMS OF PUBLISHING (3)                            |                                |
505. INTERNATIONAL PRESS PROBLEMS (3-6) Legal and communications problems of the international flow of news and opinion; international press codes.  
*Mr. Markham*
506. SEMINAR IN COMMUNICATIONS RESEARCH METHODS (3-6) Social science measuring techniques for readership and advertising studies, media effectiveness, and propaganda results.  
*Mr. Markham*
508. HISTORY AND LITERATURE OF JOURNALISM (3) Readings and research in biography, history, collections of journalistic writings, and critical works. *Mr. Brown*
513. CURRENT PROBLEMS IN NEWS REPORTING AND EDITING (3) Securing, writing, display, and treatment of the news; newsroom policies and ethics. *Mr. Marbut*
521. NEWS MEDIA AND PUBLIC OPINION (3) Problems in the function, techniques, and responsibilities of press, radio, and television in forming and interpreting opinion. Prerequisite: Pl.Sc. 427, Psy. 429, or Soc. 431. *Mr. Pockrass*
540. CONTEMPORARY ADVERTISING PROBLEMS (3) Current problems and trends in the fields of advertising copy, media, planning, and research; policies and ethical standards. *Messrs. Davis and Hicks*

## MATHEMATICS

ORRIN FRINK, *Head of the Department*  
210 Sparks Building

Graduate work leading to the M.A. and Ph.D. degrees is offered. To be admitted without undergraduate deficiency, an applicant should have credit for at least two advanced courses beyond integral calculus.

Graduate courses in all the principal branches of mathematics are offered each year. The department is equipped to direct research in a variety of fields, including function theory, abstract algebra, topology, number theory, statistics, numerical analysis, and all aspects of mathematical logic and foundations. A digital computer is available on the campus for students interested in numerical methods.



MATHEMATICS (MATH)

- 403. MODERN METHODS IN GEOMETRY (3)
- 404. THEORY OF NUMBERS (3)
- 405. PARTIAL DIFFERENTIAL EQUATIONS (3)
- 407. FOUNDATIONS OF ALGEBRA AND GEOMETRY (3)
- 408. APPLICATIONS OF MATHEMATICS (3)
- 409-410. PROBABILITY AND STATISTICS (3 each)
- 411. FINITE DIFFERENCES (3)
- 412. ALGEBRAIC EQUATIONS (3)
- 413-414. MATHEMATICS OF SCIENCE FOR TEACHERS (3 each)
- 417. VECTOR AND TENSOR ANALYSIS (3)
- 419. ANALYTICAL MECHANICS (3)
- 420-421. ADVANCED CALCULUS (3 each)
- 428. (Phil. 428). LOGICAL THEORY (3)
- 431. DIFFERENTIAL EQUATIONS (3)
- 441. DETERMINANTS AND MATRICES (3)
- 451-452. INTRODUCTION TO APPLIED MATHEMATICS (3-6 each)
- 453. MATHEMATICS FOR DIGITAL COMPUTERS (3)
- 471. FOUNDATIONS OF ALGEBRA (3)
- 472. FOUNDATIONS OF GEOMETRY (3)
- 481. VECTORS AND MATRICES (3)
- 491. TOPICS IN APPLIED MATHEMATICS (3-9)
  
- 500. ANALYTICAL MECHANICS (3) An exposition of rigid dynamics, the potential function, and Lagrange's equations. Prerequisite: Math. 419 or Phys. 461.
- 501-502. THEORY OF FUNCTIONS OF A REAL VARIABLE (3 each) Theory of real functions, sets, measure, derivatives, and integrals. Prerequisite: Math. 420.
- 503. FOURIER SERIES AND HARMONIC FUNCTIONS (3) Fourier series and integrals; spherical harmonics, Bessel functions, etc., with special emphasis on their applications. Prerequisites: Math. 44, 420.
- 505. INTEGRAL EQUATIONS (3) Fredholm and Volterra equations, and applications. Prerequisite: Math. 421.
- 507. CALCULUS OF VARIATIONS (3) Prerequisites: Math. 44, 421.
- 508-509. THEORY OF FUNCTIONS OF A COMPLEX VARIABLE (3 each) Development of the complex number system; theory of analytic functions. Prerequisite: Math. 421.
- 510. THEORY OF GROUPS (3) General properties of groups with applications. Prerequisite: Math. 471 or 535.
- 511. LINEAR ALGEBRA AND MATRIX THEORY (3) Vector spaces and linear transformations, canonical representations, elementary divisors and invariant factors. Prerequisite: Math. 481.
- 513-514. ADVANCED ANALYTIC GEOMETRY (3 each) Introduction of homogeneous coordinates and their use in the study of projective properties. Prerequisite: Math. 43.
- 520-521. PROJECTIVE GEOMETRY (3 each) General study of the subject from the postulational standpoint. Prerequisite: Math. 43. Alternate years or as required.

## MATHEMATICS

- 522-523. METRIC DIFFERENTIAL GEOMETRY (3 each) The usual classical treatment of the subject. Prerequisite: Math. 43.
- 530-531. TOPOLOGY (3 each) Topological spaces, combinatorial topology, applications to algebra and analysis.
534. THEORY OF ALGEBRAIC NUMBERS (3) Introduction to the number theory of quadratic fields, with study of the theory of ideals in quadratic and higher fields, with application. Prerequisite: Math. 404, 471.
- 535-536. MODERN ALGEBRAIC THEORIES (3 each) Groups, rings, ideals, algebraic number fields, Galois theory. Prerequisite: Math. 471.
- 542-543. THEORY OF STATISTICS (3 each) Univariate and multivariate distributions, sampling distributions, theory of estimation, statistical hypotheses. Prerequisites: Math. 409, 421.
- 550-551. MATHEMATICAL LOGIC (3 each) The logical basis of mathematics and its ultimate nature. Prerequisite: Math. 471, or Math. or Phil. 428.
- 552-553. NUMERICAL METHODS (3 each) Procedures for practical calculation, including interpolation, solution of equations, iterative methods, harmonic analysis and use of modern calculating equipment. Prerequisite: Math. 420.
- 560-561. THEORY OF DIFFERENTIAL EQUATIONS (3 each) Prerequisites: Math. 44, 421.
565. FUNCTIONAL ANALYSIS (3) Theory of Banach and Hilbert spaces, including functionals and operators, and related topics. Prerequisite: Math. 420.
570. SPECIAL TOPICS IN GEOMETRY (3-6)
571. SPECIAL TOPICS IN ANALYSIS (3-6)
572. SPECIAL TOPICS IN ALGEBRA (3-6)
573. SPECIAL TOPICS IN APPLIED MATHEMATICS (3-6)
574. SPECIAL TOPICS IN FOUNDATIONS OF MATHEMATICS (3-6)
- 575-576. MATHEMATICS SEMINAR (1-6 each) Selected topics from recent mathematical developments.

## MECHANICAL ENGINEERING

NORMAN R. SPARKS, *Head of the Department*  
207 Mechanical Engineering Building

The department offers graduate work leading to the M.S., M.Eng., and Ph.D. degrees. Graduate programs in this field emphasize heat power or machine design. Courses and facilities available permit studies in heat transfer, advanced machine design, internal combustion engines, machine dynamics, gas turbines and gas dynamics, lubrication, automatic control systems, and power generation and utilization.

## MECHANICAL ENGINEERING

A student admitted for advanced work in this field must be a graduate of an accredited curriculum in mechanical engineering. Graduates of other accredited engineering curriculums may be admitted, but will be required to make up undergraduate deficiencies without graduate credit.

### MECHANICAL ENGINEERING (M E)

401a,b,c,d. MECHANICAL ENGINEERING (3-12)

402. AIR CONDITIONING (3)

403. ROCKET PROPULSION (3)

409. GAS TURBINES (3)

410. POWER PLANTS (3)

411. REFRIGERATION (3)

412. FUNDAMENTALS OF HEAT TRANSFER (3)

413. INTERNAL COMBUSTION ENGINES (3)

417. THEORY OF ENGINEERING INSTRUMENTS (3)

450. DESIGN OF MACHINE TOOLS (3)

451. ADVANCED MACHINE DESIGN PROBLEMS (3)

452. MACHINE DESIGN ANALYSIS (3)

453. BEARING DESIGN AND LUBRICATION (3)

455. AUTOMATIC CONTROL SYSTEMS (3)

457. ADVANCED MECHANISMS (3)

502. ADVANCED GAS TURBINES (3-6) Thermodynamic and stress analysis design of gas turbine and compressor units. Prerequisite: M.E. 409.

504. ADVANCED ENGINEERING THERMODYNAMICS (3-6) Pure and applied thermodynamics including its application to advanced engineering problems; collateral reading and discussion of the classical works on the subject. Prerequisite: M.E. 32.

505. HEAT TRANSMISSION (3-6) Applications of principles of heat transfer to efficient design of mechanical engineering equipment. Prerequisite: M.E. 412.

506. MECHANICAL ENGINEERING SEMINAR (1-4) Advanced courses adapted to the individual requirements of graduates in mechanical engineering.

507. ADVANCED INTERNAL COMBUSTION ENGINES (3) Performance and design of carburetor and fuel-injection reciprocating engines, including compound and free-piston types, from the thermodynamic viewpoint. Prerequisite: M.E. 413.

510. MIXTURE PREPARATION AND COMBUSTION IN INTERNAL COMBUSTION ENGINES (3-6) Performance and design of carburetors and injection systems; combustion and its control in spark-ignition and compression-ignition engines. Prerequisite: M.E. 413.

550. ANALYSIS OF DESIGN PROBLEMS (3) Case problems in machine design requiring integrated application of engineering knowledge.

552. ADVANCED DYNAMICS OF MACHINES (3-6) Linear and torsional vibrations in and balancing of rotating and reciprocating machinery; exact analysis of stresses produced by these and other dynamic forces in machine parts. Prerequisites: E.Mch. 12, M.E. 54.

553. FRICTION AND LUBRICATION (3) The hydrodynamic theory of lubrication and methods of applying it to bearing design, together with a survey of methods of testing lubricants.



## MECHANICAL ENGINEERING

555. AUTOMATIC CONTROL SYSTEMS (3) Advanced problems and techniques in the design of automatic control systems with emphasis on stability, controller design, and optimum performance. Prerequisite: M.E. 455.
557. MECHANISM SYNTHESIS (3) Design and analysis of mechanisms for specific motion and energy requirements; intermittent mechanisms. Prerequisite: M.E. 457.
580. INVESTIGATION PROJECTS (2-6) Special experimental studies or investigations in mechanical engineering, adapted to individual requirements.

## METALLURGY

AMOS J. SHALER, *Head of the Department*  
5 Mineral Sciences Building

The department offers studies leading to the M.S. and Ph.D. degrees. There is opportunity to specialize, both in research and in course work, in chemical metallurgy, physical metallurgy, mechanical metallurgy, or the science of metals. Minor work in any of these specializations is available for students majoring in another field.

The requirements for admission are a satisfactory bachelor's degree in metallurgy, metallurgical engineering, chemistry, chemical engineering, physics, mechanical engineering, or engineering mechanics; or a satisfactory bachelor's degree in another field, provided it has included the equivalents of mathematics through integral calculus; 8 credits of physics; 12 of chemistry; 10 of other scientific, engineering, or mineral science fields; and 10 of metallurgy. Students who lack some of these requirements may be admitted but are required to take the prerequisite courses without being able to apply them toward an advanced degree.

### METALLURGY (METAL)

405. FERROUS METALLOGRAPHY (3)
406. NONFERROUS METALLOGRAPHY (3)
407. METALLURGICAL ENGINEERING I (3)
408. METALLURGICAL ENGINEERING II (3)
409. METALLURGICAL INVESTIGATIONS I (3)
410. METALLURGICAL INVESTIGATIONS II (3)
411. ADVANCED PHYSICAL METALLURGY (3)
412. EXPERIMENTAL METALLURGY (3)
413. ADVANCED CHEMICAL METALLURGY (3)
501. METALLURGICAL PROBLEMS (1-6 per semester) Independent study of special problems in metallurgy. Prerequisites: Metal. 411, 413.
502. SEMINAR IN METALLURGY (1-6) Conferences, reading, reports, and special lectures.
505. NUCLEAR REACTOR MATERIALS (3) Extractive metallurgy, alloy theory, transformations, physical properties, mechanical behavior, and corrosion of principal reactor materials; radiation damage; fuel element manufacture. Prerequisites: Metal. 59, E.Mch. 13.

## METALLURGY

515. CORROSION OF METALS (3) Phenomena and theories of metallic corrosion; principles of alloy selection for engineering and structural uses in corrosive environments. Prerequisites: Metal. 411, 413. *Mr. Read*
516. FLOW AND FRACTURE OF SOLIDS (3) Phenomenological and theoretical treatment of flow and fracture in solids. *Mr. Shaler*
518. CONSTITUTION OF METALLURGICAL SYSTEMS (3) Application of thermodynamic principles to study of heterogeneous equilibrium in alloy, slag, and slag-metal systems. Prerequisites: Metal. 411, 413. *Mr. Davis*
519. ADVANCED FERROUS METALLURGY (3) Physicochemical principles in the smelting and refining of iron and steel; slag control; solidification and primary forging of steel. Prerequisites: Metal. 411, 413. *Mr. Muan*
520. FOUNDRY METALLURGY (3) Principles of foundry metallurgy; application to foundry operations for various ferrous and nonferrous casting alloys. Prerequisites: Metal. 411, 413.
522. SOLID-PHASE REACTIONS IN METALS (3) Mechanism and rate determining factors in solid-phase reactions in metals; diffusion processes, nucleation theory, precipitations from solid solution, eutectoid decomposition and order-disorder phenomena. Prerequisites: Metal. 411, 413.
524. ADVANCED METAL WORKING (3) Elements of mathematical theory of plasticity; metal working processes; measurement of deformations in metal working; theory of metal working. Prerequisite: Metal. 516. *Mr. Shaler*
525. METAL FINISHING (3) Metallic coatings and their metallurgical properties; theories and problems of application, utilization, and evaluation. Prerequisites: Metal. 411, 413. *Mr. Read*
- NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in metallurgical studies are listed under Mineral Sciences in Part II of this bulletin.

## METEOROLOGY

HANS NEUBERGER, *Head of the Department*  
323 Mineral Industries Building

Graduate programs leading to the M.S. and Ph.D. degrees are offered. Candidates may specialize in aerosol and cloud physics, various phases of dynamic meteorology including turbulence and atmospheric circulation, atmospheric optics, macro- and microclimatology, agricultural meteorology, synoptic meteorology, or meteorological instrumentation.

Undergraduate requirements for admission include mathematics through differential equations, one year of college physics, and 12 credits in meteorology. Students may be admitted with deficiencies in some of the prerequisites but must make up such deficiencies before they are admitted to candidacy for a degree. This applies particularly to students with a strong background in mathematics, physics, or engineering.

## METEOROLOGY

### METEOROLOGY (METEO)

- 400. METEOROLOGY FOR TEACHERS (3)
  - 411. INTRODUCTION TO SYNOPTIC METEOROLOGY (3)
  - 412. SYNOPTIC METEOROLOGY (3)
  - 418. INTRODUCTORY PHYSICS OF THE UPPER ATMOSPHERE (3)
  - 420. TROPICAL METEOROLOGY (3)
  - 430. INTRODUCTION TO SYNOPTIC METEOROLOGY LABORATORY (3)
  - 431. SYNOPTIC METEOROLOGY LABORATORY I (3)
  - 432. SYNOPTIC METEOROLOGY LABORATORY II (2-10)
  - 433. ADVANCED SYNOPTIC ANALYTICAL TECHNIQUES (3)
  - 443. PHYSICAL METEOROLOGY (3)
  - 445. HYDROMETEOROLOGY (3)
  - 450. APPLICATIONS OF STATISTICS TO METEOROLOGY (3)
  - 451. THERMODYNAMICS OF THE ATMOSPHERE (3)
  - 452. HYDRODYNAMICS OF THE ATMOSPHERE (3)
  - 461. THEORY OF METEOROLOGICAL INSTRUMENTS (3)
  - 472. PHYSICAL AND DYNAMIC CLIMATOLOGY (3)
  - 492. METEOROLOGICAL SEMINAR (2)
  
  - 500. METEOROLOGICAL SEMINAR (1-3) Discussion of meteorological reports and papers; scientific outlook. Prerequisites: Meteo. 412, 451.
  - 502. SELECTED TOPICS OF ADVANCED METEOROLOGY (2) Current problems in meteorology. Prerequisite: a minimum of 15 credits in meteorology.
  - 503. ATMOSPHERIC TURBULENCE (3) Atmospheric diffusion, heat conduction, friction, and evaporation; statistical properties of turbulence.
  - 504. ADVANCED DYNAMIC METEOROLOGY (3) Introduction to perturbation theory with application to gravitational and long waves; principles of dynamic-numerical forecast methods. Prerequisite: Meteo. 452.
  - 505. BIOCLIMATOLOGY (2) Climatic phenomena in their relation to life. Prerequisite: Meteo. 472.
  - 506. ADVANCED METEOROLOGICAL ANALYSIS (2-6) Physical analysis of atmospheric phenomena; synoptic analysis of weather phenomena for advanced students. Prerequisite: Meteo. 412.
  - 507. DYNAMIC OCEANOGRAPHY (2) Physical properties of sea water; heat balance of the oceans; theory and observations of ocean currents, waves, and tides.
  - 508. PHYSICS OF THE UPPER ATMOSPHERE (2) Temperature distribution, composition, and electrical characteristics of the upper atmosphere; theories of aurora and light of the night sky.
  - 509. THEORETICAL CLIMATOLOGY (2) Theory of latitudinal, annual, and diurnal temperature changes; theories of climatic changes; microclimate.
  - 510. CLOUD PHYSICS (2) Current theories on phase changes in clouds and mechanisms responsible for precipitation; techniques of cloud modification and control.
- NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in meteorological studies are listed under Mineral Sciences in Part II of this bulletin.



## MINERAL ECONOMICS

JOHN D. RIDGE, *Head of the Department*  
207 Mineral Sciences Building

The department offers graduate work leading to the M.S. and Ph.D. degrees. A student may specialize in the economics of exploration for, and the extraction, beneficiation, and utilization of, the ferrous and nonferrous metals, the nonmetallics, the fuels, and ground water. Work is also offered in property evaluation, analysis of mineral data, and the influence of technological advances on mineral economics.

The requirements for admission are 24 credits in chemistry, physics, and mathematics; 12 in geology, mineralogy, and/or the biological sciences; 9 in mineral economics, economics, commerce, and/or geography; and 6 in mining, metallurgy, petroleum engineering, ceramics, and/or industrial engineering.

Students having a deficiency of 9 credits or fewer in this total of 51 may be admitted as regular graduate students but will be required to make up such deficiencies without the credits being applicable toward the advanced degree.

### MINERAL ECONOMICS (MN EC)

- 400. SEMINAR (1)
- 453. NONMETALLIC MINERALS (3)
- 463. MINERAL ECONOMY OF THE U.S.S.R. (3)
- 483. THE METALS AND THEIR ORES (3)
- 484. THE SOLID FUELS (3)
- 486. PETROLEUM AND NATURAL GAS ECONOMICS (3)
- 490. MINERAL VALUATION (3)
- 491. ANALYSIS OF MINERAL DATA (2)
- 500. ADVANCED PRINCIPLES OF MINERAL ECONOMICS (3-6) Economic history of mineral industries, research methods, economics of mineral exploitation and utilization, mineral policy.
- 501. RESEARCH IN MINERAL ECONOMICS (3-6) Investigation in specialized fields of research in mineral economics. Prerequisite: 3 credits in Mn.Ec. 500.
- 502. TECHNOLOGIC INFLUENCES (3-9) Relationship of technologic advancements to economic development of the mineral industries. Prerequisite: 3 credits in Mn.Ec. 500.
- 505. PROBLEMS OF MINERAL ECONOMICS (3-12) Determination of basic technologic-economic patterns of selected mineral industries. Prerequisite: 3 credits in Mn.Ec. 500.

## MINERAL PREPARATION

H. BEECHER CHARMBURY, *Head of the Department*  
4 Mineral Industries Building

Areas in which students may specialize in this department include the fundamentals of gravity, electrical, and chemical methods of beneficiating natural mineral deposits. Graduate work may also be undertaken on the properties of specific minerals as they are related to beneficiation. The M.S. and Ph.D. degrees are offered.

## MINERAL PREPARATION

Graduates with a bachelor's degree in such scientific fields as chemistry, physics, and mathematics, and in such engineering fields as mining, metallurgy, ceramics, fuel technology, and mechanical, electrical, and civil engineering are eligible for admission to an advanced degree program in mineral preparation. However, graduates in the above fields are required to take 6 credits of undergraduate courses in mineral preparation along with their graduate program.

### MINERAL PREPARATION (MN PR)

- 400. MINERAL PREPARATION SEMINAR (1)
- 403. FLOWSHEETS OF MINERAL PREPARATION PLANTS (3)
- 404. PLANT LAYOUT AND DESIGN (3)
- 410. COAL PREPARATION (3)
- 415. MINERAL PREPARATION TESTING (2)
- 416. UNIT OPERATIONS (3)
- 457. FIELD TRIP (1)
  
- 502. FROTH FLOTATION AND AGGLOMERATION (3) Intensive study of theory and applications of froth flotation and agglomeration. Prerequisite: Mn.Pr. 416. *Mr. Sun*
- 504. MINERAL PREPARATION RESEARCH (3-10) Research work on specific problems in mineral preparation. Prerequisite: Mn.Pr. 416 or 410. *Mr. Charmbury and Staff*
- 505. GRAVITY PROCESSES AND MISCELLANEOUS METHODS OF MINERAL PREPARATION (3) Intensive study of theory and applications of gravity, magnetic, electrostatic, centrifugal, and dense-media processes of mineral concentration. Prerequisite: Mn.Pr. 416. *Mr. Mitchell*
- 506. MINERAL PREPARATION PLANT DESIGN (3-10) Layout, design, and selection of equipment for specific mineral preparation plant projects. Prerequisite: Mn.Pr. 416. *Mr. Mitchell*

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in mineral preparation studies are listed under Mineral Sciences in Part II of this bulletin.*

## MINERALOGY AND PETROLOGY

JOHN C. GRIFFITHS, *Head of the Department of Mineralogy*  
114 Mineral Sciences Building

Graduate instruction and research leading to the M.S. and Ph.D. degrees is offered. Areas of specialization include igneous, sedimentary, and metamorphic petrology, mineralogy, crystal chemistry, X-ray mineralogy, clay mineralogy, ore mineralogy, and applications of statistics in the earth sciences.

The general requirements for admission are mathematics through integral calculus, chemistry through quantitative analysis, 10 credits of general physics, 30 credits of geology, petrology, and mineralogy including microscopical petrography (i.e., an equivalent to Min. 483, acceptable to the faculty).

Additional specific requirements must be fulfilled in most areas of specialization. Deficiencies may, in most cases, be made up after admission.

## MINERALOGY AND PETROLOGY

### MINERALOGY (MIN)

460. OPTICAL MINERALOGY (3) *Mr. Wright*
483. PETROGRAPHY (4) *Messrs. Griffiths and Thornton*
500. OPTICAL CRYSTALLOGRAPHY OF MINERALS (3) Optical methods, microscopic techniques, and measurement of optical constants of crystals; theory and application of the universal stage. Prerequisite: Min. 460. *Mr. Wright*
- 501a. PETROLOGY (3-6) Microscopic study of rocks, emphasizing classification and genetic relationships. *Messrs. Krynine, Tuttle, and Griffiths*
502. MINERALOGICAL PROBLEMS (3) Original study of some limited mineralogical or petrological problems.
504. THEORETICAL MINERALOGY (3) Crystal chemistry and crystal physics applied to solid solution, polymorphism, crystal growth, and related phenomena. *Mr. Bates*
505. MINERALOGY SEMINAR (1-2) Reading, presentation, and discussion of literature dealing with various phases of theoretical mineralogy. Topics are selected to meet the interests of the majority of the students. *Messrs. Krynine, Tuttle, Bates, Griffiths, and Brindley*
- \*510. METAMORPHIC PETROLOGY (2-6) Detailed review of chemical, mineralogical, and structural changes that take place during metamorphism. Prerequisite: Min. 483. *Mr. Thornton*
511. SEDIMENTARY PETROLOGY (3-4) Composition, texture, structure, mass properties of sediments; dynamic processes in complex natural systems; sedimentary stages: weathering, erosion, transport, deposition, and lithification. Prerequisite: Min. 483. Concurrent: Min. 513. *Mr. Krynine*
512. SEDIMENTARY PETROLOGY, CONTINUED (2-4) Diastrophism and tectonic background of sedimentation; depositional loci; classification of sediments: quartzites, graywackes, arkoses; chemical sediments; paleogeography, paleoclimatology, oil finding. Prerequisite: Min. 511. Concurrent: Min. 514. *Mr. Krynine*
513. METHODS OF ANALYSIS OF SEDIMENTS (3) Principles and practices used in analyzing sedimentary rocks for size, shape, and accessory (heavy) minerals. Concurrent: Min. 511. *Mr. Griffiths*
514. APPLIED SEDIMENTOLOGY (3) Design and control in analysis of sedimentary rocks; application of these techniques to industrial problems. Concurrent: Min. 512. *Mr. Griffiths*
- †517. SEDIMENTS OF THE WORLD (1-9) Microscopic and field studies of representative American and foreign rock suites; correlation with paleogeographic, geotectonic, economic data. Prerequisites: Min. 512, 514. *Mr. Krynine*
- ‡518. LIMESTONES AND DOLOMITES (2-6) End member concept in the study of composition, texture, structure, field distribution, and origin of carbonates and cherts. Prerequisite: Min. 483. *Mr. Krynine*

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\* Credits to be arranged, 2-4 per semester.

† Credits to be arranged, 1-3 per semester.

‡ Credits to be arranged, 2-3 per semester.



## MINERALOGY AND PETROLOGY

- ‡519. OIL RESERVOIR PETROLOGY (2-6) Petrographic fundamentals controlling porosity, storage capacity, oil accumulation, effective permeability, fluid yield and retention, exploration and production methods. Prerequisites: Min. 512, 514, 516. *Messrs. Krynine and Griffiths*
520. STUDY OF ACCESSORY MINERALS (2-4) Detailed study of accessory (heavy) minerals; their significance in problems of provenance, petrogenesis, mineral stratigraphy, and paleogeography. Prerequisites: Min. 511, 512, 513, 514. *Mr. Griffiths*
521. COLOR IN MINERALS (1-2) Nature of light absorption as a function of chemical composition for solutions, glasses, and minerals. *Mr. Weyl*
524. INTRODUCTION TO SEDIMENTATION (3) Concurrent: Min. 483. *Mr. Krynine*
525. IGNEOUS PETROLOGY (2-6) Origin, distribution, and composition of igneous rocks. Prerequisites: Min. 483, 500, 527; G.G. 513. *Mr. Tuttle*
526. STATISTICAL PROBLEMS IN SEDIMENTARY GEOLOGY (3) Application of experimental design, sampling procedures, multiple regression and discriminant analysis in solving problems in sedimentary petrography. Prerequisites: Min. 514; Math. 410 or Agro. 545. *Mr. Griffiths*
527. IGNEOUS AND METAMORPHIC MINERALOGY (3) Structural and compositional variations of minerals in igneous and metamorphic rocks. *Mr. Smith*
528. MINERALOGICAL CRYSTALLOGRAPHY (2-3) Application of X-ray and morphological crystallography to mineralogy and petrology.
530. (Cer.T. 530). STRUCTURE, PROPERTIES, AND OCCURRENCE OF CLAY MINERALS (2-5) Structure analysis and identification of clay minerals; mineral transformations and behavior; occurrence, genesis, and petrography of fine-grained sediments. *Messrs. Griffiths, Bates, and Brindley*

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in mineralogical studies are listed under Mineral Sciences in Part II of this bulletin.

## MINING ENGINEERING

HOWARD L. HARTMAN, *Head of the Department of Mining*  
305B Mineral Industries Building

Graduate work leading to the M.S. and Ph.D. degrees is offered. Areas of specialization which may be followed in research and course work include mine property valuation and economics of mining engineering (ore estimation, cost analysis and control, budgeting), mechanization and mine plant (unit operations, materials handling, continuous mining, power supply), development and exploitation methods (mine planning and layout, design of systems), production engineering and operational analysis (time study, standards, job rating, operations research), environmental control (gas and dust technology, ventilation, air conditioning, hygiene, illumination, safety), and rock mechanics (stress analysis, roof and ground control, penetration, fragmentation).

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‡ Credits to be arranged, 2-3 per semester

A bachelor's degree in mining engineering or some related engineering field is required for admission to graduate work. Students may be required to make up deficiencies in their area of specialization.

Certain basic, related fields outside the department may be considered for inclusion as part of the major.

#### MINING (MNG)

- 401. MINE PLANT ENGINEERING I (3)
- 402. MINE PLANT ENGINEERING II (3)
- 411. MINE PRODUCTION ENGINEERING (2)
- 412. MINE MANAGEMENT AND SUPERVISION (2)
- 422. MINE VENTILATION AND AIR CONDITIONING (3)
- 424. MINE SAFETY ENGINEERING (1)
- 431. ROCK MECHANICS (2)
- 451-452. ADVANCED MINING ENGINEERING I and II (1 each)
- 490. SENIOR MINING SEMINAR (1)
- 513. MINE COST ANALYSIS (3) Nature of mining costs, their analysis and control: depreciation and depletion, capital and operating costs, budgets, records.
- 514. MINE OPERATIONS ANALYSIS (3) Scientific planning and layout of mining operations based on time studies, mathematical analysis, and proportionality of centroids of reserves. Prerequisites: Math. 44 or 45, Mng. 411.
- 525. DUST TECHNOLOGY (3) Physical and chemical properties of dusts; airborne dust determinations and analysis; dust control applicable to mills and mines. Prerequisite: Mng. 422.
- 526. MINE VENTILATION (3) Airflow in mine openings and its control; network solution by mathematics and computer; design of mine and industrial ventilation systems. Prerequisite: Mng. 422.
- 528. MINE AIR CONDITIONING (3) Thermodynamics of vapor mixtures; heat flow through rock; physiological effects of hot, humid environments; design of temperature-humidity control systems. Prerequisite: Mng. 422.
- 532. ROCK MECHANICS (3) Behavior of rock under static loading; underground stress instrumentation; experimental stress analysis; design of mine openings; theories of subsidence. Prerequisite: Mng. 431.
- 541. THEORY OF ROCK PENETRATION (3) Behavior of rock under dynamic loads intended to penetrate; basic energy relations; application of theory to drilling and other penetration. Prerequisites: Phys. 285, Mng. 31.
- 542. THEORY OF ROCK FRAGMENTATION (3) Behavior of rock under dynamic loads intended to fragment; physical chemistry of explosives; detonation; theory of blasting; design of drill rounds. Prerequisites: Phys. 285, Mng. 31.
- 580. MINING ENGINEERING RESEARCH (1-3 per semester) Supervised research on a specific problem involved in mining science or technology.
- 590. GRADUATE MINING SEMINAR (1 per semester) Preparation and presentation of formal papers on problems of an advanced nature in mining engineering. Required each semester in residence.

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in mining studies are listed under Mineral Sciences in Part II of this bulletin.

## MUSIC

HUMMEL FISHBURN, *Head of the Department*  
217 Carnegie Building

Graduate work in music leads to the M.A. degree. Students may emphasize one of the following areas, or may elect a program including work in all of them: theory, performance, music literature, and creative music. The minor is chosen from the liberal arts. Admission to this graduate program requires completion of a recognized music curriculum.

## MUSIC (MUSIC)

407. PIANO LITERATURE (3)  
 408. VOCAL LITERATURE (3)  
 410. MUSIC OF THE 20TH CENTURY (3)  
 411. LITERATURE OF THE VIOLIN (3)  
 \*429. SINGER'S STYLE AND INTERPRETATION (3) Fee \$50.  
 456. ELEMENTARY COUNTERPOINT (3)  
 459. MODERN INSTRUMENTAL ARRANGING (3)  
 466. ADVANCED CONDUCTING (3)
- \*503. ADVANCED STRINGED INSTRUMENTS (3) Study, repertoire building, and recital performance. Fee \$50.
- \*511. ADVANCED PIANO (3) Piano literature of all periods for public performance. Fee \$50.
- \*531. ADVANCED ORGAN (3) Study, repertoire building, and recital performance. Prerequisite: 4 credits of Music 31 and/or 38. Fee \$60.
543. MODERN HARMONY (3) Harmonic writing based on 20th century practices with attention to traditional idioms that serve as foundation.
557. SYMPHONIC STRUCTURE (3) Survey of the evolution and application of the forms used in symphony, sonata, concerto, string quartet, and related works. Prerequisite: Music 57.
- \*558. FREE COMPOSITION (3) Composition: vocal and instrumental, standard or modern idioms. Prerequisite: 18 credits in harmony, counterpoint, and piano.
563. FREE ARRANGING (3) Correct procedure in arranging for vocal and instrumental ensembles; practical exercises in quartets, glee clubs, and choruses; small instrumental groups, band, and orchestra. Prerequisite: 18 credits in harmony, including 3 of orchestration.
567. THE LITERATURE OF THE ORCHESTRA (3) The suite, symphony, tone poem, and overture from the point of view of appreciation, form, and orchestration. Prerequisites: Music 6 and theoretical knowledge of the key instruments of the orchestra.

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\* May be repeated for a total of 12 credits.



## MUSIC EDUCATION

HUMMEL FISHBURN, *Head of the Department*  
217 Carnegie Building

The department offers graduate work leading to the M.Ed. and D.Ed. degrees with a major in music education and a minor in music. The program for the master's degree includes some courses in general education, and the program for the doctor's degree includes considerable work in general education.

At the doctoral level emphasis may be upon work in vocal, instrumental, or theoretical music in elementary, secondary, or college teaching; but the degree requires work in all of these fields. Admission to the graduate program requires completion of a recognized music education curriculum.

## MUSIC EDUCATION (MU ED)

- 462. PEDAGOGY OF THEORY (3)
- 468. THE TEACHING OF PIANO (3)
- 469. BAND AND ORCHESTRA TECHNIQUE (3)
- 470. CHORAL TECHNIQUE (3)
- 475. OBJECTIVES AND PROBLEMS IN ELEMENTARY MUSIC EDUCATION (3)
- 480. CHORAL PROGRAM IN THE SECONDARY SCHOOL (3)
  
- 500. MUSIC EDUCATION SEMINAR (3-6) Problems of various phases of music education, both instrumental and vocal; research and literature dealing with these problems.
  
- 569. PRESENT-DAY TRENDS IN INSTRUMENTAL MUSIC (3) New methods and materials for band, orchestra, and ensembles.
  
- 571. VOCAL PEDAGOGY (3) Detailed study of vocal problems met in public schools, elementary through high school; vocal class pedagogy and literature; daily voice training. Prerequisites: Mu.Ed. 48, teaching experience.
  
- 572. INSTRUMENTAL PEDAGOGY (3-6) Research problems in band and orchestra. Prerequisite: Mu.Ed. 54 or practical experience.
  
- 573. THE MATERIALS OF APPRECIATION (3) Methods and materials for development of music appreciation in elementary and secondary schools. Prerequisites: Music 5, teaching experience.
  
- 574a,b. PRESENT-DAY TRENDS IN MUSIC EDUCATION (3-6) Present-day music education materials and methods (elementary and secondary levels) in relation to modern educational philosophy; emphasis upon practical problems presented by members of the class. Prerequisites: Mu.Ed. 48, teaching experience.
  
- 575. THE JUNIOR HIGH SCHOOL MUSIC CURRICULUM (3) Instructional materials, procedures, curricular and extracurricular activities, integration with other subjects.
  
- 576. MUSIC SUPERVISION (3) Current educational procedures in training music supervisors.
  
- 580. FIELD PROJECTS IN JUNIOR AND SENIOR HIGH SCHOOL MUSIC (3) Curricular problems to be carried on under actual school conditions; individual work under supervision. Prerequisites: teaching experience, 30 credits of graduate study.

## MUSIC EDUCATION

594. PEDAGOGY OF EAR TRAINING (3) Materials and methods for training the listener to grasp, understand, and write what is heard from melody to four-part harmony. Prerequisite: 12 credits in eartraining and/or harmony.

## NUCLEAR ENGINEERING

WARREN W. MILLER, *Chairman of the Committee on Nuclear Engineering*  
206 Walker Laboratory

The M.S. and M.Eng. degrees are offered in nuclear engineering. Admission requires a bachelor's degree in engineering or in the physical sciences. Students who have not had appropriate undergraduate courses in nuclear physics and partial differential equations will be required to schedule them. A student may specialize in reactor analysis, nuclear materials, or reactor instrumentation and control.

### PHYSICAL SCIENCE (PH SC)

501. SEMINAR IN NUCLEAR SCIENCE AND ENGINEERING (0)

## PETROLEUM AND NATURAL GAS ENGINEERING

ROBERT L. SLOBOD  
*Head of the Department of Petroleum and Natural Gas*  
26 Mineral Industries Building

The M.S. and Ph.D. degrees are offered with a major in petroleum and natural gas engineering. Areas of specialization include experimental and theoretical studies of water flooding and the newer methods for displacing oil from porous media, methods for calculating reservoir performance, scaled laboratory studies of reservoir phenomena, and drilling and well completion problems.

Students who expect to enter graduate study in this field with a degree in another curriculum should present 20 credits of chemistry and physics, 6 of geology, 15 of engineering science, and credit for mathematics through integral calculus. A limited number of deficiencies may be made up after admission.

Certain closely related courses outside the department may be counted as petroleum and natural gas credits toward the degree.

### PETROLEUM AND NATURAL GAS (P N G)

421. RESERVOIR ENGINEERING (3)  
431. DRILLING FLUIDS (2)  
481. NATURAL GAS AND GASOLINE PLANTS (2)  
485. SECONDARY RECOVERY (3)  
490. ADVANCED CORE TESTING (3)  
510. FLOW OF HOMOGENEOUS FLUIDS THROUGH POROUS MEDIA (3) Concepts and mathematics describing steady and unsteady state flow in porous media for various initial and boundary conditions.  
\*512. RESERVOIR ENGINEERING (3-6) Applications of the principles of fluid behavior in porous media to the analysis of complex reservoir behavior; log interpretation. Prerequisite: P.N.G. 510.

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\* Credits to be arranged, 3 per semester.

## PETROLEUM AND NATURAL GAS ENGINEERING

515. SECONDARY RECOVERY (3) Methods of predicting oil recovery by immiscible fluid injection.
517. CASE STUDIES OF SECONDARY RECOVERY (1-3) Interpretation and critical analysis of production and injection characteristics of typical water flood operations. Prerequisite: P.N.G. 515 or 485.
520. PHASE RELATIONS IN RESERVOIR ENGINEERING (3) Phase relations as applied to condensate and retrograde condensate reservoirs and to other problems in petroleum production.
525. SPECIAL TOPICS IN PETROLEUM ENGINEERING (2-6)
530. NATURAL GAS ENGINEERING (1-3) Flow in producing or storage reservoirs; gas well testing; transmission systems; storage cycles; current developments. Prerequisite: P.N.G. 481.
- †535. SEMINAR (1-3)

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in petroleum and natural gas studies are listed under Mineral Sciences in Part II of this bulletin.*

## PHILOSOPHY

JOHN M. ANDERSON, *Head of the Department*  
106 Sparks Building

The department offers graduate work leading to the M.A. and Ph.D. degrees. A student may concentrate on history of philosophy, logic and scientific methods, or value theory. Undergraduate preparation should include a major in philosophy, but a strong minor may also be acceptable.

### PHILOSOPHY (PHIL)

406. MEDIEVAL PHILOSOPHY (3)
410. STUDIES IN GREEK PHILOSOPHY (3-6)
411. STUDIES IN MODERN PHILOSOPHY (3-6)
414. AESTHETIC THEORY (3)
418. RECENT AND CONTEMPORARY PHILOSOPHY (3)
419. PHILOSOPHICAL BACKGROUNDS OF AMERICAN THOUGHT (3)
425. PHILOSOPHY OF LAW (3)
426. METAPHYSICS (3)
427. ADVANCED ETHICS (3)
428. (Math. 428). LOGICAL THEORY (3)
429. SEMANTICS: PHILOSOPHY OF LANGUAGE AND SYMBOLISM (3)
430. PHILOSOPHICAL PROBLEMS (3-6)
500. ETHICS: HISTORICAL AND SYSTEMATIC (2-6) Critical study of some phase of ethical theory, or of some period of the history of ethics.

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† Credits to be arranged, 1 per semester.



## PHILOSOPHY

503. LOGIC (3) The logical basis of mathematics and its ultimate nature.
504. SOCIAL AND POLITICAL PHILOSOPHY (3) Critical study of basic problems in their historical and functional setting.
505. IDEALS OF WESTERN CIVILIZATION (3) Analysis of contemporary ideals in terms of their Graeco-Judean bases.
507. SEMINAR IN ANCIENT AND MEDIEVAL PHILOSOPHY (3-6) Study of one or more important men or movements in ancient or medieval philosophy.
508. SEMINAR IN MODERN PHILOSOPHY (3-6) Men and movements in philosophy from the Renaissance through the 19th century.
509. SEMINAR IN CONTEMPORARY PHILOSOPHY (3-6) Men and movements in 20th century philosophy.
510. CLASSICS OF SCIENTIFIC METHOD (3-6) Actual reasoning and procedures of historical masters of scientific methods.
511. PRINCIPLES OF EXPERIMENTAL INFERENCE (3-6) Science as controlled inquiry; types of scientific procedures in formal, physical, and sociocultural science.
515. PHILOSOPHICAL METHOD (3) Methods proposed by classical and contemporary thinkers for reaching philosophical conclusions: deductive, inductive, dialectical, pragmatic, intuitive.

## PHYSICAL EDUCATION

JOHN D. LAWTHER

*Associate Dean of the College of Physical Education and Athletics*  
246 Recreation Building

Programs are offered leading to the M.Ed., M.S., D.Ed., and Ph.D. degrees. Areas of specialization include: (1) history, philosophy, and principles; (2) applied science (physiology of exercise, kinesiology, body mechanics); (3) organization and administration; (4) objectives, programs, methods, and evaluation; (5) adaptives and correctives; (6) health; and (7) athletics, intramural and interschool. The master's candidate is expected to acquire a basic minimum of knowledge in each of these areas with little specialization except for his thesis or problem. The doctoral candidate is expected to focus on one area during his final year of graduate work.

The requirements for admission to the M.Ed. program are 24 semester hours in professional health and physical education and 24 in education and psychology, including general psychology, educational psychology, principles and methods of teaching, education electives, and practice teaching.

The requirements for admission to the M.S. program are 36 semester hours in professional health and physical education and 18 in education and psychology. An excellent background in the biological and physical sciences may satisfy up to half of the requirement in professional health and physical education.

PHYSICAL EDUCATION (PH ED)

441. ADVANCED COACHING OF ATHLETICS FOR MEN (1 per unit)  
*Unit A. Basketball (1)* *Unit G. Swimming (1)*  
*Unit B. Football (1)* *Unit H. Gymnastics (1)*  
*Unit C. Track and Field (1)* *Unit I. Boxing (1)*  
*Unit D. Baseball (1)* *Unit J. Lacrosse (1)*  
*Unit E. Wrestling (1)* *Unit K. Fencing (1)*  
*Unit F. Soccer (1)*
449. ADVANCED TEACHING OF SPORTS AND RHYTHMICS (1 per unit)  
*Unit A. Soccer and Speedball (1)* *Unit H. Early American Country*  
*Unit B. Basketball (1)* *Dancing and Social Dancing*  
*Unit C. Field Hockey (1)* (1)  
*Unit D. Archery (1)* *Unit I. Tennis (1)*  
*Unit E. Swimming (1)* *Unit J. Badminton (1)*  
*Unit F. Rhythmics for Children (1)* *Unit K. Golf (1)*  
*Unit G. Modern Dance and Accom-*  
*paniment (1)*
452. ANALYSIS OF PHYSICAL EDUCATION ACTIVITIES FOR THE ELEMENTARY SCHOOL (3)  
453. ANALYSIS OF PHYSICAL EDUCATION ACTIVITIES FOR THE HIGH SCHOOL (3)  
454. THE NATURAL PROGRAM OF PHYSICAL EDUCATION ACTIVITIES, APPLIED (3)  
455. SCIENTIFIC METHOD IN HEALTH AND PHYSICAL EDUCATION (3)  
460. METHODS AND PRINCIPLES OF ATHLETIC COACHING (3)  
480. ADVANCED ANATOMY AND PHYSIOLOGY, APPLIED (3)  
489. INTRAMURAL ATHLETICS (3)  
490. INTRODUCTION TO TESTS AND MEASUREMENTS IN HEALTH AND PHYSICAL EDUCATION (3)  
491. ORGANIZATION AND ADMINISTRATION OF HEALTH AND PHYSICAL EDUCATION IN SCHOOLS (3)
500. PROBLEM IN PHYSICAL EDUCATION (3) Prerequisite: Ph.Ed. 455.
522. ORGANIZATION AND ADMINISTRATION OF PHYSICAL EDUCATION IN COLLEGES AND UNIVERSITIES (3) Administration of physical education in college; credits, schedules, excuses, records, reports, budgets, classification, tests, staff, and facilities. Prerequisite: Ph.Ed. 491.
523. ADMINISTRATION OF COLLEGE ATHLETICS (3) Eligibility, schedules, managerial systems, relationships of athletics to the physical education program and to education in general. Prerequisite: Ph.Ed. 491.
526. ATHLETIC PROBLEMS IN SCHOOLS (3) Practical problems which result from administration of athletics in schools. Reports on some aspects of athletics required. Prerequisite: Ph.Ed. 460.
528. PROFESSIONAL EDUCATION OF TEACHERS OF HEALTH AND PHYSICAL EDUCATION (3) Health and physical education surveys, publicity, sociability and personality tests, legislation, state certification, standards for facilities and equipment, in-service, follow-up, and teacher-community problems. Prerequisite: Ph.Ed. 491.
529. SUPERVISION OF PHYSICAL EDUCATION IN SCHOOLS (3) Methods and policies of the school supervisor of physical education; conferences, planning and presenting the program, evaluating results, improving teachers-in-service, supervision of the classroom teacher. Prerequisite: Ph.Ed. 491.

## PHYSICAL EDUCATION

530. RESEARCH TECHNIQUES IN HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (3) Prerequisite: Ph.Ed. 490.
531. RESEARCH IN HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (3) Prerequisite: Ph.Ed. 530.
532. TESTS AND MEASUREMENTS IN PHYSICAL EDUCATION (3) Critical study of tests and measurements available in physical education; methods of constructing and evaluating new tests and measurements. Prerequisite: Ph.Ed. 490.
534. STUDIES IN CURRICULUM CONSTRUCTION IN PHYSICAL EDUCATION (3) Principles and methods of curriculum building in physical education; different psychological and educational points of view, organizing a course of study committee, making units of instruction. Prerequisite: Ph.Ed. 454.
535. MODERN FOREIGN SYSTEMS OF PHYSICAL EDUCATION (3) Comparative analysis of national and local programs and systems of physical education in foreign countries. Prerequisites: Ph.Ed. 534, 595.
536. SCIENTIFIC METHODS IN ATHLETIC COACHING (3) Unusual techniques in athletic coaching which are not commonly recognized and used; advanced skills and strategy in coaching major sports. Prerequisite: Ph.Ed. 460.
550. SEMINAR IN HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (1-6) Open only to students preparing approved theses.
555. RELATIONSHIPS OF PHYSICAL EDUCATION TO THE EXACT SCIENCES (3)
560. ADMINISTRATIVE PROBLEMS OF PHYSICAL EDUCATION IN SCHOOLS (3) Solutions to problems emerging from the administration of physical education in schools, fitting physical education into the school's schedule, awards and budgets. Prerequisite: Ph.Ed. 491.
581. PROBLEMS IN BODY MECHANICS (3) Certain aspects of human motion and body segmental alignment; analysis of human gait, and the dynamic adaptation of the spine, thorax, and pelvis to external physical forces. Prerequisites: Hl.Ed. 244, Ph.Ed. 399.
595. PHILOSOPHY OF HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (3) Prerequisite: Hl.Ed. 453 or Ph.Ed. 491 or Rc.Ed. 465.

## PHYSICAL SCIENCE

HENRY W. KNERR

*Chairman of the Committee on Physical Science*

104 Willard Building

The M.Ed. degree is offered with a major in physical science. The program, which is designed to meet the needs of secondary school science teachers, consists of at least 24 credits chosen from chemistry, geology, mathematics, and physics and a minor of at least 6 credits in basic education. A candidate is expected to complete at least one course in each of the four sciences and at least 12 credits in one of them.

As a minimum requirement for admission a student is expected to have had 10 credits in chemistry, 8 credits in physics, mathematics through trigonometry, and 27 credits in education, including educational psychology and practice teaching.



## PHYSICS

JOHN A. SAUER, *Head of the Department*  
101 Osmond Laboratory

The Department of Physics offers graduate work leading to the M.S. and Ph.D. degrees. Graduate instruction and research opportunities are available in visible and infrared spectroscopy, crystal structure, solid state, field emission, acoustics, high-pressure physics, biophysics, electronics, shock waves, low-temperature physics, nuclear physics, physics of high polymers, and various phases of theoretical physics.

A bachelor's degree in physics or an allied field is required for admission. Students who lack some of the usual upper-class undergraduate courses in physics may be requested to take additional course work without degree credit.

## PHYSICS (PHYS)

- 400. INTERMEDIATE ELECTRICITY AND MAGNETISM (4)
- 402. ELECTRONICS (4)
- 404. ELECTRONIC MEASUREMENTS (2-4)
- 406. NUCLEAR PHYSICS (3)
- 411. THEORETICAL MECHANICS (3)
- 412. THEORY OF THE SOLID STATE (3)
- 417. THE TEACHING OF PHYSICS (3)
- 420. INTERMEDIATE HEAT (3)
- 433. MECHANICS AND FLUID PHYSICS FOR TEACHERS (3)
- 435. ELECTRICITY AND MAGNETISM FOR TEACHERS (3)
- 436. OPTICS FOR TEACHERS (3)
- 437. HEAT, WAVE MOTION, AND SOUND FOR TEACHERS (3)
- 439. ELEMENTARY SURVEY OF MODERN PHYSICS FOR TEACHERS (3)
- 441. DEMONSTRATION EXPERIMENTS FOR TEACHERS (3)
- 443. INTERMEDIATE ACOUSTICS (3)
- 444. MEASUREMENTS IN ACOUSTICS (2)
- 454. ATOMIC AND NUCLEAR PHYSICS (3)
- 456. ATOMIC AND NUCLEAR PHYSICS (3)
- 457. EXPERIMENTAL ATOMIC PHYSICS (2)
- 458. INTERMEDIATE OPTICS (4)
- 461. THEORETICAL MECHANICS (3)
- 467. INTERMEDIATE ELECTRICITY AND MAGNETISM (3)
- 470. SPECIAL TOPICS (1-9)
- 473-474. BIOPHYSICS (3 each)
- 477. X-RAY ANALYSIS OF SOLIDS AND LIQUIDS (3)
- 507. THERMODYNAMICS AND KINETIC THEORY (3) Classical and modern thermodynamics; introduction to statistical mechanics.
- 509. PHYSICS SEMINAR (1-3 per semester) Topics from current research.
- 512-513. SOLID STATE PHYSICS (3 each) Analytical treatment of physical properties of solids: crystal structure, X-ray diffraction, lattice vibrations, paramagnetism, ferromagnetism, ferroelectricity; electron theory of metals, semi-conductors. Prerequisite: Phys. 530.
- 517. STATISTICAL MECHANICS (3) Classical and quantum statistics, theory of ensembles, degenerate gases, applications to low temperature effects and co-operative phenomena. Prerequisites: Phys. 507, 561.

## PHYSICS

521. CRYSTAL STRUCTURE (3) Crystal symmetry, X-ray scattering, theory and techniques of crystal structure determination.
522. ADVANCED CRYSTAL ANALYSIS (3) Phase-determining methods in crystal analysis.
530. THEORETICAL MECHANICS (4) Newtonian mechanics; Lagrange's equations, Hamilton's principle; Hamilton's equations; coupled systems; waves in strings, central field problem; rigid bodies; elasticity; hydrodynamics.
532. ADVANCED THEORETICAL MECHANICS (3) Least action principle; canonical transformation; Lagrange and Poisson brackets; Hamilton-Jacobi equations; classical theory of fields. Prerequisite: Phys. 530.
533. THEORETICAL ACOUSTICS (3) Vibrating systems; transmission of disturbances through elastic and visco-elastic media. Prerequisite: Phys. 530.
- 553-554. NUCLEAR PHYSICS (3 each) Discussion and theoretical interpretation of basic experiments involving atomic nuclei and nuclear radiations. Prerequisite: Phys. 562.
557. ELECTRICITY AND MAGNETISM (3) Electro- and magnetostatics, Maxwell's equations, boundary value problems, electric and magnetic properties of material media.
558. ADVANCED ELECTRICITY AND MAGNETISM (3) Energy and momentum in the field, radiation theory, classical relativistic electron theory. Prerequisite: Phys. 557.
560. RESEARCH PROBLEMS (1-18) Introduction to research through individual assignments.
- 561-562. QUANTUM MECHANICS (3 each) The basic theory of wave and matrix mechanics, approximation methods, applications. Prerequisite: Phys. 530.
565. REACTOR ANALYSIS (4) Physical principles and mathematical methods of reactor analysis. Prerequisite: Phys. 406.
566. REACTOR ANALYSIS (3) Continuation of Phys. 565. Prerequisite: Phys. 565.
571. ATOMIC PHYSICS (3) Experimental basis of modern physics; atomic spectra and structure, nuclear phenomena.
572. SELECTED TOPICS IN SPECTROSCOPY (3) Atomic and molecular spectra, experimental methods and theoretical analyses.
575. SPECIAL TOPICS (1-3 per semester) Theoretical studies in any field of modern physics with or without associated experimental work. Prerequisite: Phys. 456.

## PLANT PATHOLOGY

JESSE E. LIVINGSTON

*Head of the Department of Botany and Plant Pathology*  
206 Buckhout Laboratory

The M.S. and Ph.D. degrees are offered in this field. The student may specialize in the study of plant diseases caused by fungi, bacteria, or viruses, and/or in their control, especially by plant breeding or by chemical means.

For admission a student must present at least 27 credits in botany, plant pathology, and biological science, of which not more than 6 may be in biological science. As many as 6 credits may be made up as undergraduate deficiencies after the candidate has been admitted to the Graduate School.

Courses in plant pathology are listed under botany. See especially Bot. 408, 412, 419, 421, 428, 429, 501, 509, 515, 519, 520, 521, 522, 523, 526, 529, 530, and 531.

## POLITICAL SCIENCE

M. NELSON McGEARY, *Head of the Department*  
129 Sparks Building

The M.A. and Ph.D. degrees are offered in this field. Students may specialize in American government, political theory, international relations, or comparative government. A Master of Public Administration degree is also offered in a special program built around Pl.Sc. 560, 561, and 562.

For admission to graduate work students should present 12 to 15 hours of undergraduate work in the field, or its equivalent.

### POLITICAL SCIENCE (PL SC)

- |                                                                       |                                       |
|-----------------------------------------------------------------------|---------------------------------------|
| 401. POLITICAL BEHAVIOR (3)                                           | Mr. Sorauf                            |
| 411. AMERICAN POLITICAL THEORY (3)                                    | Mr. Riemer                            |
| 413. GOVERNMENT AND POLITICS OF THE SOVIET UNION (3)                  | Mr. Atwater                           |
| 414. FOREIGN POLICY OF THE SOVIET UNION (3)                           | Mr. Aspaturian                        |
| 415. INTERNATIONAL ORGANIZATION (3)                                   | Mr. Aspaturian                        |
| 416. INTERNATIONAL LAW (3)                                            | Mr. Aspaturian                        |
| 417. MUNICIPAL GOVERNMENT (3)                                         | Mr. Corter                            |
| 419. PUBLIC ADMINISTRATION (3)                                        | Mr. McGeary                           |
| 421. MODERN POLITICAL THEORY (3)                                      | Mr. Riemer                            |
| 424. STATE GOVERNMENT IN THE UNITED STATES (3)                        |                                       |
| 426. POLITICAL PARTIES (3)                                            | Miss Silva                            |
| 427. PUBLIC OPINION AND PROPAGANDA (3)                                | Miss Silva                            |
| 428. PENNSYLVANIA LOCAL GOVERNMENT (3)                                | Mr. Corter                            |
| 429. PENNSYLVANIA LOCAL ADMINISTRATION (3)                            | Mr. Corter                            |
| 431. ANCIENT AND MEDIEVAL POLITICAL THEORIES (3)                      | Mr. Riemer                            |
| 432. CURRENT POLITICAL TRENDS AND PROBLEMS IN THE UNITED STATES (3-9) |                                       |
|                                                                       | Messrs. Riemer and Sorauf, Miss Silva |
| 433. AMERICAN LABOR LAW (3)                                           | Mr. Brewster                          |
| 442. AMERICAN FOREIGN POLICY (3)                                      | Mr. Atwater                           |
| 444. GOVERNMENT REGULATION (3)                                        | Mr. Ferguson                          |
| 445. ADMINISTRATIVE LAW (3)                                           | Mr. Brewster                          |
| 446. JUDICIAL SYSTEMS (3)                                             | Mr. Law                               |
| 451. COMPARATIVE GOVERNMENT (3)                                       |                                       |
| 456. GOVERNMENTS AND FOREIGN POLICIES OF LATIN AMERICA (3)            | Mr. Law                               |
| 458. GOVERNMENTS AND FOREIGN POLICIES OF THE FAR EAST (3)             | Mr. Aspaturian                        |
| 499. FOREIGN STUDY IN GOVERNMENT (2-6)                                |                                       |
| 500. SEMINAR IN POLITICAL SCIENCE (3-12)                              | Subject to be announced. Mr. Brewster |
| 505. SEMINAR IN ADVANCED AMERICAN GOVERNMENT (3-12)                   |                                       |
| 508. RESEARCH IN PUBLIC ADMINISTRATION (3-12)                         | Mr. McGeary                           |



## POLITICAL SCIENCE

509. RESEARCH TECHNIQUES IN POLITICAL SCIENCE (3) *Miss Silva*
510. POLITICAL AND ADMINISTRATIVE PROBLEMS IN PENNSYLVANIA (3-6) *Mr. McGeary*
512. COMPARATIVE GOVERNMENT (3-12) *Mr. Atwater, Miss Silva*
515. INTERNATIONAL RELATIONS (3-6) *Mr. Atwater*
517. INTERNATIONAL ORGANIZATION (3-6) *Mr. Aspaturian*
519. PUBLIC ADMINISTRATION (3-6) *Mr. McGeary*
521. POLITICAL THEORY (3-6) *Mr. Riemer*
535. GOVERNMENT REGULATION (3-6)
560. PUBLIC MANAGEMENT I (15) Organization, management, personnel, budgeting, accounting, and other fiscal procedures in government at all levels.
561. PUBLIC MANAGEMENT II (15) Administrative law, communications and report writing, statistics, public relations, public works administration, and planning in government at all levels. Prerequisite: Pl.Sc. 560.
562. PUBLIC MANAGEMENT III (6) Supervised internship and report. Prerequisite: Pl.Sc. 561.

## POULTRY HUSBANDRY

ARTHUR J. G. MAW, *Head of the Department*  
103 Weaver Building

Graduate study programs lead to the M.S. and Ph.D. degrees in the following areas of specialization: poultry nutrition, poultry management, poultry products, poultry breeding, or animal behavior. In each area the program consists of a joint major between the Department of Poultry Husbandry and one or more basic science departments. Admission requirements vary according to the area of specialization. Students with undergraduate majors in the basic sciences may qualify.

Excellent facilities are available for research in production, processing, and preservation of market eggs and dressed poultry, and in chick and poult nutrition. A specially designed and equipped Solar Laying House also provides facilities for investigation of production and behavioral problems encountered in large, concentrated populations of layers.

### POULTRY HUSBANDRY (P H)

401. (Psy. 401, Zool. 401). ANIMAL BEHAVIOR (3) *Mr. Hale*
412. POULTRY BREEDING (3) *Mr. Buss*
502. ADVANCED POULTRY NUTRITION (2-4) Prerequisite: P.H. 3. *Mr. Murphy*
503. ADVANCED POULTRY FARM MANAGEMENT (2-4) Prerequisite: P.H. 8. *Mr. Bressler*
504. ADVANCED MARKET POULTRY AND EGGS (2-4) Prerequisites: P.H. 1, 7; Ag.Ec. 33 or 2 additional credits in poultry husbandry. *Messrs. Margolf and Mueller*

505. RESEARCH IN POULTRY HUSBANDRY (1-15 per semester) Prerequisite: 9 credits in poultry husbandry.

506. SEMINAR IN POULTRY HUSBANDRY (1-6)

582. (Psy. 582, Zool. 582). RESEARCH IN ANIMAL BEHAVIOR (2-6 per semester)  
Research in special areas of animal behavior involving field or laboratory work.  
Prerequisite: P.H., Psy., or Zool. 401; or Psy. 403. *Messrs. Hale and Schein*

## PSYCHOLOGY

ARTHUR H. BRAYFIELD, *Head of the Department*  
112 Burrowes Building

The department offers graduate work leading to the M.S. and Ph.D. degrees. In special cases the M.Ed. and the D.Ed. may be obtained.

Areas in which a student may specialize are: (1) clinical psychology, which includes professional training for mental hygiene clinics, colleges, and institutions; (2) educational and developmental psychology, which prepares for college teaching, teacher education, and educational clinics; (3) experimental and general psychology, which prepares for college teaching and for academic and professional specialties; (4) school psychology, which prepares for work in the public schools and for the Pennsylvania State Certificate as a Public School Psychologist; (5) industrial and business psychology, which prepares for positions in the application of psychology to business, industry, institutions, and state and federal agencies; (6) social psychology, which prepares for college teaching, work in applied social psychology—group dynamics, delinquency, attitude studies, and communications; and (7) psychological measurements and statistics, which provide basic skills for college teaching, work in admission and evaluation programs, test publishing organizations, state and federal agencies, and for most of the areas listed above.

The Penn State Anechoic Chamber provides an exceptional facility for research in hearing for students in experimental and industrial psychology. The Psychology Clinic offers unique training in the clinical and counseling areas. Closed-circuit television facilities also enable interested students to gain experience with research in teaching and the use of this medium.

Requirements for admission include a broad undergraduate preparation, a junior-senior scholastic average of approximately B, a minimum of 12 credits in psychology, and a satisfactory graduate student rating on a scholastic aptitude examination. Applicants with a master's degree will have their admission evaluated with emphasis on the quality of their graduate program.

### PSYCHOLOGY (PSY)

- 400. HONORS COURSE IN PSYCHOLOGY (2-6)
- 401. (P.H. 401, Zool. 401). ANIMAL BEHAVIOR (3)
- 403. INTRODUCTORY PHYSIOLOGICAL PSYCHOLOGY (3)
- 407. INTERMEDIATE EXPERIMENTAL PSYCHOLOGY (3)
- 411. PSYCHOLOGY OF THE PRESCHOOL CHILD (3)
- 412. ABNORMAL PSYCHOLOGY (3)
- 414. INTERMEDIATE EDUCATIONAL PSYCHOLOGY (2-3)
- 415. INTERMEDIATE STATISTICS IN PSYCHOLOGY AND EDUCATION (3)
- 417. SOCIAL PSYCHOLOGY (2-3)
- 418. MEASUREMENT OF PERSONALITY (3)

*Mr. Hale*  
*Mr. Slivinske*  
*Mr. Lepley*  
*Mr. Whaley*  
*Mr. Guthrie*  
*Mr. Thevaos*  
*Mr. Ray*  
*Mr. Carpenter*

## PSYCHOLOGY

419. GUIDANCE AND EDUCATION IN SEXUAL AND MARITAL ADJUSTMENT (3) *Mr. Adams*
420. APPLIED SOCIAL PSYCHOLOGY (3) *Mr. Carpenter*
422. PSYCHOLOGICAL METHODS OF MEASURING THE REACTIONS OF THE PUBLIC (3)  
*Mr. Guest*
423. TEST CONSTRUCTION AND STANDARDIZATION (2-3) *Mr. Ray*
425. PSYCHOLOGY OF THE ELEMENTARY SCHOOL CHILD (2-3) *Mr. VanOrmer*
426. ADOLESCENCE (2-3) *Mr. Thevaos*
427. PSYCHOLOGICAL PRINCIPLES IN ADVERTISING (3) *Mr. Guest*
428. OPINION RESEARCH LABORATORY (3) *Mr. Guest*
429. PSYCHOLOGY OF COMMUNICATION (3) *Mr. Slivinske*
431. INDUSTRIAL PSYCHOLOGY (3) *Mr. Smith*
432. INTRODUCTORY ENGINEERING PSYCHOLOGY (3) *Mr. Corso*
436. MENTAL HYGIENE IN SCHOOLS (3) *Mr. Gorlow*
437. PSYCHOLOGY OF ADJUSTMENT (3) *Messrs. Gorlow and Grosslight*
438. THEORY OF PERSONALITY (3) *Mr. Siegel*
440. PSYCHOLOGY PROJECTS (1-6)
441. INDUSTRIAL MOTIVATION AND MORALE (3)
445. (C.D.F.R. 445). DEVELOPMENT THROUGHOUT ADULTHOOD (3)
450. MEASUREMENT OF ABILITIES (3) *Mr. Ray*
482. INTRODUCTION TO CLINICAL PSYCHOLOGY (3) *Mr. Snyder*
500. SEMINAR: INTRODUCTION TO GRADUATE STUDY (0) For all new graduate students in psychology. *Mr. Carpenter*
501. ADVANCED PSYCHOLOGY (3) Comprehensive study of general psychology. Prerequisite: 9 credits in psychology. *Mr. Lepley*
502. ADVANCED EDUCATIONAL PSYCHOLOGY (2-4) Psychological theories and principles underlying educational theories and practices. Prerequisites: Psy. 14 or 414; Ed. 31 or teaching experience. *Messrs. Thevaos and Whaley*
503. PHYSIOLOGICAL PSYCHOLOGY (2-6) Correlations between structure and function of nervous system and human consciousness; laws and theories in fields of sensation, attention, association, affection, and thought. Prerequisite: 9 credits in psychology. *Mr. Slivinske*
504. COMPARATIVE PSYCHOLOGY (2-4) Behavior from standpoint of phylogenetic growth and development; biological implications; comparison of different types of animals, including man. Prerequisite: 9 credits in psychology. *Mr. Hale*
505. RESEARCH PROBLEMS IN PSYCHOLOGY (1-15) Prerequisite: 12 credits in psychology.
509. ADVANCED THEORY OF LEARNING AND HABIT FORMATION (2-3) Critical evaluation of major theories of learning: Hull, Guthrie, Tolman, Lewin. Application of learning theory to major problems in psychology. Prerequisite: Psy. 4 or 407 or 414. *Mr. Grosslight*
510. HISTORY OF PSYCHOLOGY (3) Theoretical systems, experiments, and personalities in development of modern psychology until about 1920. Prerequisite: 9 credits in psychology. *Mr. Carpenter*
511. CONTEMPORARY AMERICAN PSYCHOLOGY (2-3) Current systems or schools of psychology with comparative study and critical analysis; points of view as presented by recognized leaders. Prerequisite: 9 credits in psychology. *Mr. Hall*



513. EDUCATIONAL PSYCHOLOGY: DIFFERENTIAL (3) Causes of differences in achievement and personality; psychological implications of methods used by schools in adjusting to individual differences. Prerequisites: Psy. 14 or 414; 6 credits at 400 level in psychology *Mr. VanOrmer*
514. EDUCATIONAL PSYCHOLOGY: LEARNING (2) Experimentally determined facts about the learning process; synthesis of main theories of learning; application of principles related to: motivation, practice, retention, transfer, meaning, and problem solving. Prerequisites: Psy. 14 or 414; 6 credits at 400 level in psychology. *Messrs. VanOrmer and Thevaos*
515. ADVANCED STATISTICS IN PSYCHOLOGY AND EDUCATION (3) Correlation theory and methods, discriminant function, and factor analysis; applications to mental test theory. Prerequisite: Psy. 415 or Ed. 574. *Mr. Siegel*
517. PSYCHOLOGY OF ATTITUDES AND OPINIONS (3) Acquisition and control of attitudes and opinions, including beliefs, convictions, biases, prejudices, and ideologies as determinants of action. Prerequisite: 18 credits in psychology, including Psy. 417, 422, 437.
518. PROJECTS IN EXPERIMENTAL PSYCHOLOGY (2-4) Individual experimental projects; seminars on experimental design and instrumentation. Prerequisite: Psy. 407.
522. SURVEY RESEARCH TECHNIQUES (3) Sample and questionnaire designs for investigation of consumer reactions and social issues, and appropriate analytic procedures. Prerequisite: 3 credits in statistics. *Mr. Guest*
525. SAMPLING DESIGNS IN MARKET AND OPINION RESEARCH (3) Techniques in selection of samples for accurate representation of human populations; special emphasis on probability sampling. Prerequisite: 3 credits in statistics. *Mr. Guest*
527. STATISTICAL INFERENCE AND EXPERIMENTAL DESIGN (3) Probability theory, sampling distributions, analysis of variance and covariance, analysis of trend, non-parametric statistics, experimental design. Prerequisite: Psy. 415 or Ed. 574. *Mr. Ray*
528. OPINION RESEARCH ADMINISTRATION (3-6) Practicum in planning, development of techniques, and administration of the sample survey. Prerequisites: Psy. 15, 21, 422. *Mr. Guest*
529. (C.D.F.R. 529). SEMINAR IN CHILD DEVELOPMENT (1-6) Readings and reports on recent findings in child development. Prerequisite: 6 credits in child development or 6 in educational or child psychology, plus 3 in statistics.
534. ADVANCED ENGINEERING PSYCHOLOGY (3) Experimental studies of psychological factors affecting design and operation of machines. Prerequisites: Psy. 3 and 4, or Psy. 432 or 501. *Mr. Corso*
535. HUMAN DEVELOPMENT (2-3) Psychological phases of human development throughout the life span; implications for school, community, and home. Prerequisite: 9 credits in psychology. *Messrs. VanOrmer and Whaley*
536. RESEARCH METHODS AND PROBLEMS IN EDUCATIONAL AND DEVELOPMENTAL PSYCHOLOGY (1-6) Prerequisites: Psy. 414 or 514; Ed. 470 or Psy. 415.
537. SEMINAR IN INDUSTRIAL PSYCHOLOGY (3) Prerequisite: Psy. 431. *Mr. Smith*

## PSYCHOLOGY

538. **PSYCHOLOGY OF PERSONNEL DEVELOPMENT (3)** Industrial training in relation to psychological learning theory and experimental findings. Prerequisite: Psy. 431 or 414. *Mr. Smith*
539. **MOTIVATION AND EMOTION (3)** Systematic status of instinct, drive, motive, will, purpose; methodology and results of physiological, experimental, and clinical investigation of basic drives. Prerequisite: Psy. 503. *Mr. Hall*
540. **SEMINAR IN CLINICAL PROBLEMS (1-6)** Contemporary psychological theory, research, and methodology in relation to clinical psychology. Prerequisites: Psy. 542, 560.
541. **PERSONALITY THEORY (3-4)** Contemporary theories of personality and relevant research with emphasis upon normal processes. Prerequisite: Psy. 438. *Mr. Gorlow*
542. **PSYCHOPATHOLOGY (3-4)** Theories of pathological behavior with reference to clinical and experimental data. Prerequisites: Psy. 412, 541. *Dr. Lott*
543. **SURVEY OF COUNSELING AND PSYCHOTHERAPY (3)** Critical analysis of important systems of psychotherapy; history, rationale, and method. Prerequisite: Psy. 541. *Mr. Snyder*
551. **THEORY AND PRACTICUM IN CLINICAL APPRAISAL OF ABILITIES AND INTELLIGENCE I (3-4)** Theories of intellectual behavior; introduction to clinical testing with emphasis on individual intelligence tests. Prerequisites: Psy. 450, 482; or 15 credits in psychology.
552. **THEORY AND PRACTICUM IN CLINICAL APPRAISAL OF ABILITIES AND INTELLIGENCE II (3)** Theory, development of tests, and research in intellectual assessment; practicum experience with institutionalized subjects. Prerequisite: Psy. 551.
553. **ADVANCED THEORY OF CLINICAL ASSESSMENT (3)** Problems in clinical assessment of cognitive functioning, such as assessment of brain injury, aphasic behaviors, etc. Prerequisites: Psy. 552, 542.
555. **THEORY AND PRACTICUM IN CLINICAL ASSESSMENT OF PERSONALITY (3)** Theoretical issues and research in clinical assessment with special reference to administration and interpretation of projective methods. Prerequisites: Psy. 552, 542. *Messrs. Guthrie and Gorlow*
556. **THEORY AND PRACTICUM IN CLINICAL ASSESSMENT OF PATHOLOGICAL SYNDROMES (3)** Current research and theoretical issues in the clinical assessment of pathological syndromes; includes practicum. Prerequisite: Psy. 555. *Messrs. Guthrie and Gorlow*
557. **ADVANCED PERSONALITY ASSESSMENT (3)** Personality and measurement theories related to problems of prediction, diagnosis, and research. Prerequisite: Psy. 556. *Messrs. Guthrie and Gorlow*
560. **PRACTICUM IN CLINICAL METHODS (3-6)** Personality and vocational diagnostic evaluations and short-term counseling with adults and children. Prerequisites: Psy. 482, 541, 551.
561. **CLINICAL PRACTICUM WITH CHILDREN (1-3)** Diagnosis and counseling of child-parent problems of learning and adjustment; includes principles of school psychology. Prerequisite: Psy. 560.



564. THEORY AND PRACTICUM IN COUNSELING AND PSYCHOTHERAPY WITH ADULTS (3-6)  
Counseling with personal adjustment problems referred to the Psychology Clinic.  
Prerequisites: Psy. 543, 560. *Mr. Snyder*
567. THEORY AND PRACTICUM IN COUNSELING AND PSYCHOTHERAPY WITH CHILDREN  
(1-3) Practical experience in the Psychology Clinic in use of play therapy with  
young children; staff meetings; seminar on principles and techniques. Prere-  
quisites: Psy. 543, 560, 564.
569. ADVANCED THEORY AND PRACTICUM IN COUNSELING AND PSYCHOTHERAPY (3-6)  
Practical experience in the Psychology Clinic in advanced nondirective therapy  
techniques; staff meetings; case conferences. Prerequisite: Psy. 564. *Mr. Snyder*
570. INTERNSHIP IN PROFESSIONAL PSYCHOLOGY (1-9) Internship, under supervision  
of graduate faculty, in institution with practicing psychologists, where student is  
not regularly employed. Prerequisite: 3 semesters of graduate work in psychology.  
*Unit A. Comparative Psychology*  
*Unit B. Educational and Developmental Psychology*  
*Unit C. General Experimental Psychology*  
*Unit D. Industrial and Business Psychology*  
*Unit E. Social Psychology*  
*Unit F. State Institutional Psychology*
571. SOCIAL PSYCHOLOGY (3) Historical development of theory and methods; de-  
terminants and principles of complex social or interactional behavior; contempo-  
rary problems and research. Prerequisites: 3 credits in social psychology.  
*Mr. Carpenter*
574. PSYCHOLOGY OF EXCEPTIONAL CHILDREN (3) Etiology, diagnosis, and facili-  
tation of adjustment of the mentally retarded, gifted, physically handicapped,  
and emotionally disturbed child. Prerequisite: Psy. 414 or 482 or Ed. 426.
580. THEORY AND CONSTRUCTION OF ATTITUDE SCALES (3) Measurement of social,  
political, commercial, and industrial attitudes; questionnaire designs. Prerequi-  
site: 3 credits in statistics. *Mr. Guest*
582. (P.H. 582, Zool. 582). RESEARCH IN ANIMAL BEHAVIOR (2-6 per semester)  
Research in special areas of animal behavior involving field or laboratory work.  
Prerequisite: Psy., P.H., or Zool. 401; or Psy. 403. *Messrs. Hale and Schein*
590. PROBLEMS IN CLINICAL RESEARCH (1-6) Prerequisite: Psy. 415.
591. SEMINAR ON TEACHING PSYCHOLOGY (1-3) Objectives and content of psychol-  
ogy; organization and presentation of material; teaching aids and techniques.  
*Mr. Whaley*

## RECREATION EDUCATION

FRED M. COOMBS, *in Charge of Recreation Education*  
244 Recreation Building

Graduate work leading to the M.Ed., M.S., D.Ed., and Ph.D. degrees is offered.  
Students may prepare for recreation administrative positions in public recreation  
systems, industries, hospitals, camps, or private agencies; or for leadership of spe-



## RECREATION EDUCATION

cial groups in a particular activity. The areas for specialization include: (1) history, philosophy, and principles; (2) administration and supervision; (3) planning areas and facilities; (4) program content and application; (5) surveys and appraisals; (6) principles of the group process; and (7) research.

For admission an undergraduate major in recreation education is desirable; but a major in sociology, music, physical education, fine or industrial arts, theatre arts, or other related fields may be accepted.

Students who lack some of the prerequisite courses may be admitted but are required to make up the deficiency without degree credit.

### RECREATION EDUCATION (RC ED)

- 430. CAMPING AND OUTDOOR EDUCATION (3)
- 434. (L.Arch. 434). RECREATION AREAS AND FACILITIES (3)
- 456. SOCIAL RECREATION (3)
- 461. COMMUNITY RECREATION (3)
- 462. RECREATION FOR THE HANDICAPPED (3)
- 465. ADMINISTRATION OF RECREATION (3)
  
- 530. CAMP ADMINISTRATION (3) Camp site development; staff selection, training, and supervision; development of objectives and program planning; values inherent in outdoor and camping education. Prerequisite: Rc.Ed. 430.
  
- 533. RECREATION STUDIES, SURVEYS, AND APPRAISALS (3) Types, purposes, and methods of conducting recreation studies and surveys; procedures in appraisal of community recreation. Prerequisite: Ph.Ed. 530.
  
- 560. ADMINISTRATIVE PROBLEMS OF RECREATION (3) Administrative problems in park and recreation departments; departmental organization, finance, personnel, facilities, program, and public relations. Prerequisite: Rc.Ed. 465.

## ROMANCE LANGUAGES AND LITERATURES

FRANKLIN B. KRAUSS

*Head of the Department of Romance Languages*  
301 Sparks Building

The M.A. and Ph.D. are offered with a major in Romance languages and literatures. The minimum requirement for admission to an advanced degree program will normally be 24 credits of post-intermediate work in language and literature. A student electing to concentrate in either French or Spanish may, if he wishes, choose the second area as a minor.

### FRENCH (FR)

- 400. FRENCH LITERATURE OF THE RENAISSANCE (3)
- 405. FRENCH LITERATURE IN THE ROMANTIC PERIOD (3)
- 406. FRENCH LITERATURE IN THE REALISTIC PERIOD (3)
- 411. FRENCH PROSE OF THE 20TH CENTURY (3)
- 413. CONTEMPORARY FRENCH DRAMA (3)
- 416. FRENCH POETRY AND DRAMA OF THE 20TH CENTURY (3)
- 421. THE TEACHING OF ROMANCE LANGUAGES (3)
- 431. FRENCH LITERATURE OF THE CLASSICAL PERIOD (3)

## ROMANCE LANGUAGES AND LITERATURES

433. THE AGE OF ENLIGHTENMENT (3)  
437. THE FRENCH ANALYTICAL NOVEL (3)  
471. PROBLEMS IN FRENCH LITERATURE (3-6)  
490. ADVANCED COMPOSITION AND CONVERSATION (3)  
496. LITERARY CRITICISM IN FRANCE, ITALY, AND SPAIN (3)
- \*1G. ELEMENTARY FRENCH FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.
501. FRENCH DRAMA OF THE CLASSICAL PERIOD (3) Origins and developments of French classical comedy and tragedy, emphasizing the works of Corneille, Racine, and Molière.
549. SYMBOLISM (3) The anti-positivistic tradition in 19th century French literature dealing with the Symbolist School, its antecedents and its subsequent ramifications.
552. MEDIEVAL FRENCH LITERATURE (3) Familiarizes the student with Old and Middle French texts from the earliest monuments to Villon. Prerequisite: R.Ph. 551.
553. FRENCH LITERATURE OF THE RENAISSANCE (3) The French Renaissance from 1498 to 1548.
562. FRENCH THINKERS OF THE 18TH CENTURY (3)
564. FRENCH ROMANTICISM (3) The French Romantic movement after 1830.
570. VOLTAIRE AND ROUSSEAU (3)
571. SEMINAR IN FRENCH LITERATURE (3-12) Lectures on methods of research. Students will pursue common and individual investigations in fields selected after consultation with the instructor.
572. SEMINAR IN FRENCH LITERATURE (3) Continuation of Fr. 571.
580. PROUST AND GIDE (3)

### ITALIAN (IT)

571. SEMINAR IN ITALIAN LITERATURE (3) Lectures on methods of research. Students will pursue common and individual investigations in fields selected after consultation with the instructor.

### PORTUGUESE (PORT)

571. SEMINAR IN PORTUGUESE LITERATURE (3-6) Prerequisite: Port. 4.

### SPANISH (SPAN)

401. THE GOLDEN AGE (3)  
402. DRAMA OF THE GOLDEN AGE (3)  
403. DON QUIXOTE (3)  
404. OLD SPANISH LANGUAGE AND LITERATURE (3)  
405. SPANISH DRAMA OF THE 19TH CENTURY (3)  
406. CONTEMPORARY SPANISH DRAMA (3)

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\* No graduate credit is given for this course.

## ROMANCE LANGUAGES AND LITERATURES

- 407. THE SPANISH NOVEL OF THE 19TH CENTURY (3)
- 408. THE CONTEMPORARY SPANISH NOVEL (3)
- 409. INTRODUCTION TO LATIN-AMERICAN LITERATURE (3)
- 410. INTRODUCTION TO LATIN-AMERICAN LITERATURE (3)
- 411. MEXICO: ITS LANGUAGE AND LITERATURE (3)
- 412. ARGENTINA: ITS LANGUAGE AND LITERATURE (3)
- 417. SPANISH LITERATURE IN THE ROMANTIC PERIOD (3)
- 421. THE TEACHING OF ROMANCE LANGUAGES (3)
- 471. PROBLEMS IN SPANISH LITERATURE (3-6)
- 490. ADVANCED COMPOSITION AND CONVERSATION (3)
- 496. LITERARY CRITICISM IN FRANCE, ITALY, AND SPAIN (3)

\*1G. ELEMENTARY SPANISH FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.

501. GOLDEN AGE LITERATURE (3) Nature and development of Spanish literature of the 16th and 17th centuries.

538. THE GENERATION OF 1898 (3) Principal works and intellectual trends of the period with special emphasis on Unamuno.

549. MODERNISMO (3) The movement, its antecedents, and its followers, with special emphasis on Rubén Darío.

552. MEDIEVAL SPANISH LITERATURE (3) Familiarizes the student with Old Spanish texts.

561-562. SPANISH DRAMA PREVIOUS TO LOPE DE VEGA (3 each) Origin and early development of the Spanish national drama. Representative plays of different types will be read and discussed.

565. LOPE DE VEGA (3)

566. LOPE DE VEGA'S FOLLOWERS (3)

567-568. CERVANTES AND HIS WORKS (3 each)

571. SEMINAR IN SPANISH LITERATURE (3-12) Lectures on methods of research. Students will pursue common and individual investigations in fields selected after consultation with the instructor.

572. SEMINAR IN SPANISH LITERATURE (3) Continuation of Span. 571.

### ROMANCE LITERATURE (R LIT)

544. NEOCLASSICISM IN THE ROMANCE LITERATURES (3) The neoclassical movement in the Romance literatures, with emphasis on French and Spanish.

545. ROMANTICISM IN THE ROMANCE LITERATURES (3) The Romantic movement in the Romance literatures, with emphasis on French and Spanish.

546. MEDIEVAL ROMANCE LITERATURES (3) Medieval writings in the Romance literatures, with emphasis on French and Spanish.

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\* No graduate credit is given for this course.



## ROMANCE LANGUAGES AND LITERATURES

547. REALISM IN THE ROMANCE LITERATURES (3) The Realistic movement in the Romance literatures, with emphasis on French and Spanish.

554. THE RENAISSANCE IN THE ROMANCE LITERATURES (3) The effect of the Renaissance on the Romance literatures, with emphasis on French and Spanish.

### ROMANCE PHILOLOGY (R PH)

551. ROMANCE PHILOLOGY (3)

558. ADVANCED LINGUISTICS AND PHONETICS OF THE ROMANCE LANGUAGES (3)

573. THEORY AND TECHNIQUES OF TEACHING THE ROMANCE LANGUAGES (1-2)

574. METHODS AND BIBLIOGRAPHY IN ROMANCE LANGUAGES AND LITERATURES (1-2)

## RURAL SOCIOLOGY

MACKLIN E. JOHN

*Head of the Department of Agricultural Economics and Rural Sociology*

1 Weaver Building

A graduate program leading to the M.S. or the Ph.D. degree is offered. The entering student in the master's program should have as prerequisites 3 credits in rural sociology, 3 credits in sociology, and 3 additional credits in either field. If he does not have these prerequisites, he may take them at this University during the early part of his master's program.

### RURAL SOCIOLOGY (R SOC)

402. CONSUMER BEHAVIOR AND THE AGRICULTURAL INDUSTRY (3)

452. RURAL ORGANIZATION (3)

454. RURAL SOCIAL WELFARE (3)

459. RURAL SOCIAL PSYCHOLOGY (3)

551. RURAL SOCIOLOGY SEMINAR (1-6) Prerequisite: 6 credits in rural sociology, sociology, or psychology.

552. ADVANCED RURAL SOCIOLOGY (3) Structure and functioning of rural society.

553. SEMINAR IN RURAL SOCIOLOGICAL RESEARCH (1-6) Continuation of R.Soc. 552. Functioning of rural society; research dealing with the subject reviewed and evaluated.

554. ADVANCED RURAL SOCIAL WELFARE (3) Analysis of welfare techniques and their application to rural situations. Prerequisites: R.Soc. 11; Psy. 2 or R.Soc. 459.

555. THE RURAL CHURCH (3) The rural church as a social institution; its relation to the community; the church in "problem" areas; effects of population trends on the program of the rural church; use of case studies and surveys. Prerequisite: 6 credits in rural sociology, sociology, or psychology.

557. THE DEVELOPMENT OF THE RURAL COMMUNITY (3) Origin and evolution of the rural community under different geographic and cultural conditions. Prerequisites: R.Soc. 11 or Soc. 1; R.Soc. 452.

559. ADVANCED RURAL SOCIAL PSYCHOLOGY (3) Application of social psychological principles to treatment of rural problems. Prerequisites: R.Soc. 11, Psy. 2.

## SOCIAL STUDIES

NEIL A. McNALL

*Chairman of the Committee on Social Studies*

115 Sparks Building

The M.Ed. degree is offered with a major in social studies. The program, which is designed to meet the needs of secondary school teachers, consists of at least 24 credits chosen from economics, history, human geography, political science, and sociology, and a minor of at least 6 credits in basic education. A candidate is expected to complete at least 3 credits in each of four fields and not more than 12 credits in one of them.

To undertake graduate work in this field, the student must have had solid preparation in the basic courses in history, political science, economics, and sociology; and he should have had some advanced undergraduate work in at least one of the fields named. He should be certified for teaching social studies, and ideally he should have had teaching experience in this field as well.

## SOCIOLOGY

WILLIAM G. MATHER

*Head of the Department of Sociology and Anthropology*

123 Sparks Building

Graduate work leading to the M.A. and Ph.D. degrees is offered in sociology. A minor may be taken in anthropology. Undergraduate preparation must include 12 credits in sociology and at least 7 in other social sciences, with a broad background in the arts and sciences preferred. Students of exceptional ability who are slightly deficient in undergraduate preparation may be accepted, on condition that they make up their deficiency in courses without degree credit.

### SOCIOLOGY (SOC)

- |                                                      |               |
|------------------------------------------------------|---------------|
| 400. SOCIOLOGICAL PRINCIPLES (3)                     |               |
| 401. SOCIAL INSTITUTIONS (3)                         | Mr. Green     |
| 403. ADVANCED SOCIAL PSYCHOLOGY (3)                  | Mr. Coutu     |
| 405. SOCIAL ADJUSTMENT IN WORK LIFE (3)              | Mr. Miller    |
| 408. SOCIAL ECOLOGY (3)                              |               |
| 413. METHODS AND TECHNIQUES OF SOCIAL RESEARCH (1-6) | Mr. Dansereau |
| 418. THE DEVELOPMENT OF SOCIAL THOUGHT (3)           |               |
| 423. POPULATION RESEARCH (3)                         | Mr. Clark     |
| 424. SOCIAL CHANGE (3)                               | Mr. Abramson  |
| 425. CONTEMPORARY SOCIOLOGICAL THEORY (3)            |               |
| 426. INTRODUCTION TO PUBLIC WELFARE (3)              | Mr. Mather    |
| 427. SOCIAL CASE WORK (3)                            |               |
| 429. SOCIAL STRATIFICATION (3)                       | Mr. Abramson  |
| 431. COMMUNICATION AND MASS SOCIETY (3)              | Mr. Abramson  |
| 450. COMMUNITY ORGANIZATION (3)                      |               |
| 455. OCCUPATIONS AND PROFESSIONS (3)                 | Mr. Miller    |
| 470. USE OF STATISTICS IN SOCIOLOGY (3)              | Mr. Clark     |
| 499. FOREIGN STUDY IN SOCIOLOGY (2-6)                |               |

## SOCIOLOGY

500. SEMINAR IN GROUP THEORY (1-3) The group as a unit of social structure and action.
503. RESEARCH SEMINAR IN SOCIAL PSYCHOLOGY (3-6) Design and conduct of research in areas of mutual interest in social psychology. *Mr. Coutu*
505. CURRENT SOCIAL THEORY (3) Current contributions to social theory; their relations to each other and to the larger theoretical structure. *Mr. Theodorson*
510. FIELD WORK IN SOCIOLOGY (1-6)
513. SEMINAR IN SOCIOLOGICAL RESEARCH PROBLEMS: A. RESEARCH TECHNIQUES; B. CURRENT RESEARCH (3-6) Prerequisite: 3 credits in statistics. *Messrs. John and Miller*
515. SEMINAR IN COMMUNITY STUDIES (3) *Mrs. Bernard*
516. SEMINAR IN SOCIOLOGICAL THEORY (3-6) *Mr. Green*
523. POPULATION PROBLEMS (1-6) *Mr. Clark*
525. SEMINAR IN SOCIOLOGY (1-6) Research problems in theoretical and applied sociology.
530. RESEARCH ON MARRIAGE AND THE FAMILY (3) Training in methods and techniques of research in family relations. Experimental, statistical, and comparative studies are carried out, individually or co-operatively. Prerequisite: 3 credits of previous work in this field. *Mrs. Bernard*
555. INDUSTRIAL SOCIOLOGY (3) Research methods and techniques in industrial sociology; current research, unexplored areas. *Mr. Miller*
572. METHODS OF SAMPLING (3) Application of sampling techniques to sociological research. *Mr. Clark*

## ANTHROPOLOGY (ANTHY)

401. PHYSICAL ANTHROPOLOGY: HUMAN EVOLUTION (3) *Mr. Baker*
402. HUMAN ECOLOGY (3) *Mr. Baker*
443. ANTHROPOLOGY OF THE OLD WORLD AND MIDDLE EAST (3) *Mr. Mook*
445. PRIMITIVE SOCIETY (3) *Mr. Mook*
540. ANTHROPOLOGICAL THEORY (3) Theory used in culture-historical, sociological, and psychological interpretations. *Mr. Mook*
541. RESEARCH METHODS IN ANTHROPOLOGY (3) Principles, techniques, and examples of both field and library research in anthropology. Students will prepare research plans for class discussion. *Mr. Dupree*
545. SEMINAR IN ANTHROPOLOGY (1-9) Critical analysis of research in selected areas of regional ethnography and ethnological theory. Prerequisites: Anthy. 45, 445. *Mr. Mook*

## ARCHAEOLOGY (ARCHY)

- 400-401. ARCHAEOLOGY OF THE NEAR EAST (3 each) *Mr. Matson*
- 402-403. ARCHAEOLOGY OF THE NEW WORLD (3 each) *Mr. Matson*



## SPEECH

ROBERT T. OLIVER, *Head of the Department*  
300 Sparks Building

Graduate programs are offered which lead to the M.A., M.Ed., D.Ed., and Ph.D. degrees. The student may specialize in speech arts (interpretation, drama, theatre); radio and television; rhetoric and public address (including discussion, communication, teaching of speech); speech science (voice, diction, phonetics, general semantics); or speech pathology and audiology.

The minimum undergraduate preparation required is 12 credits in speech, including a beginning public speaking course and speech science with group discussion and persuasion. Students who cannot meet this requirement in full may be admitted, but must make up their deficiencies without credit toward the graduate degree. If a specific course in speech research methods is not offered, Spch. 401 will be required as a part of the graduate program.

## SPEECH (SPCH)

- |                                                                                                                                                                                                                                          |                     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| 400. TEACHING OF SPEECH (3)                                                                                                                                                                                                              | <i>Mr. Schug</i>    |
| 401. PROBLEMS, METHODS, AND AREAS IN SPEECH (3)                                                                                                                                                                                          | <i>Mr. Carter</i>   |
| 402. INTRODUCTION TO GENERAL SEMANTICS (3)                                                                                                                                                                                               | <i>Mr. Carter</i>   |
| 410. ENGLISH PHONETICS AND PRONUNCIATION (3)                                                                                                                                                                                             | <i>Mr. Brubaker</i> |
| 412. SPEECH COMPOSITION (3)                                                                                                                                                                                                              | <i>Mr. DeBoer</i>   |
| 415. EXPERIMENTAL AND APPLIED PHONETICS (3)                                                                                                                                                                                              | <i>Mr. Brubaker</i> |
| 425. ADVANCED PRINCIPLES OF RADIO SPEECH (3)                                                                                                                                                                                             | <i>Mr. Nelson</i>   |
| 431. ANATOMY AND PHYSIOLOGY OF THE EAR AND VOCAL MECHANISMS (3)                                                                                                                                                                          | <i>Mr. Brubaker</i> |
| 435. TELEVISION AND RADIO ORGANIZATION (3)                                                                                                                                                                                               | <i>Mr. Nelson</i>   |
| 437. ADVANCED PRINCIPLES OF TELEVISION SPEECH (3)                                                                                                                                                                                        | <i>Mr. Nelson</i>   |
| 445. CONTEMPORARY PUBLIC ADDRESS (3)                                                                                                                                                                                                     | <i>Mr. O'Brien</i>  |
| 450. DISCUSSION TECHNIQUES (3)                                                                                                                                                                                                           | <i>Mr. Hager</i>    |
|                                                                                                                                                                                                                                          |                     |
| 500. SEMINAR IN AMERICAN ORATORY (2-4) History of American oratory, with application of critical standards to the work of specific orators. Prerequisite: 6 credits in speech, including Spch. 200.                                      | <i>Mr. Oliver</i>   |
| 505. HISTORICAL DEVELOPMENT OF SPEECH THEORY (2-4) Survey of ancient, medieval, and modern theories of public address in relation to currently accepted speech theories.                                                                 | <i>Mr. DeBoer</i>   |
| 508. SEMINAR IN BRITISH ORATORY (2-4) History of British oratory; application of critical standards to the work of selected orators.                                                                                                     | <i>Miss Fife</i>    |
| 510. SEMINAR IN SPEECH PEDAGOGY (2-4)                                                                                                                                                                                                    | <i>Mr. Carter</i>   |
| 520. SEMINAR IN SPEECH SCIENCE (2-4) Seminar in physical and physiological bases of speech and voice; introduction to laboratory techniques used in speech research. Prerequisite: 9 credits in speech, speech education, or psychology. | <i>Mr. Brubaker</i> |
| 540. SEMINAR IN PROBLEMS OF TELEVISION AND RADIO (2-4) Study and research in television and radio as they pertain to programming, production, relation to society, and speech.                                                           | <i>Mr. Nelson</i>   |

550. SEMINAR IN ORAL PERSUASION (2-4) Theory and devices of persuasion; analysis of persuasive discourse. Prerequisite: 6 credits in speech including Spch. 200. *Mr. Oliver*
552. ORAL COMMUNICATION IN INDUSTRY, BUSINESS, AND GOVERNMENT (2-4) Needs, practices, and methods in American industry, business, and government; methods of training adults in oral communication skills. *Mr. Zelko*
555. SPEECH COMMUNICATION: PROBLEMS AND PRINCIPLES (2-4) Prevalent theories of speech influence. *Mr. Oliver*
560. PUBLIC ADDRESS (2-4) Discussion and criticism of speech outline, manuscript, content, composition, and delivery. Prerequisite: 6 credits in speech including Spch. 200. *Mr. Schug*
575. RESEARCH PROBLEMS IN SPEECH (1-12) Advanced research on an individual basis in oratorical criticism, discussion techniques, persuasion, pedagogy, phonetics, speech science, and speech pathology. Prerequisite: 12 credits in speech or in speech education.

## STATISTICS

JAMES B. BARTOO, *Chairman of the Committee on Statistics*  
219 Sparks Building

Statistics may be used as a field of study for a minor in an advanced degree program. This minor is intended to facilitate development of a coherent program of study in this vital branch of the scientific method.

An acceptable program should permit the candidate to become conversant with the broad field of statistics and to become reasonably proficient in the statistical methods particularly useful in the subject-matter areas of his major field. The member of the candidate's committee representing the minor in statistics will have responsibility and jurisdiction for determining course work acceptable in satisfying requirements for the minor in statistics.

The minimum requirements for a minor for a master's degree are 3 credits in mathematical statistics and 6 in applied statistics. For a doctor's degree a minimum of 15 credits in statistics is required for a minor, of which at least 6 must be mathematical statistics and at least 6 must be applied statistics.

Courses in mathematical statistics are: Math. 409, 410, 542, and 543.

Courses in applied statistics are: Ag. 400; A.B.Ch. 515; Ag.Ec. 505; Ag.Ed. 521v; Agro. 512, 545; B.S. 500, 501; Econ. 480; Ed. 470, 574; I.E. 423; Meteo. 450; Min. 513, 514, 526; Psy. 415, 515, 527; and Soc. 470, 572.

## THEATRE ARTS

WALTER H. WALTERS, *Head of the Department*  
201 Schwab Auditorium

The M.A. degree is offered with a major in theatre arts. Under certain circumstances the Ph.D degree is offered by the Department of English Literature with specialization in drama and minor work in theatre arts.

A course in basic acting, one in directing, and one in theatre crafts, or their equivalents, are required for admission. In addition, the student must have had 12

## THEATRE ARTS

credits divided between speech and the arts (including music, sculpture, painting, architecture, and other courses in which art is practiced); or a minimum of 9 credits in one of these; or a minimum of 9 credits in English and literature, including at least 6 in dramatic literature, or 3 in dramatic literature and 3 in advanced creative writing.

### THEATRE ARTS (THEA)

- 403. ADVANCED MAKE-UP (1)
- 404. STYLES OF ACTING (3)
- 412. ADVANCED SCENE DESIGN (3)
- 413. STAGE LIGHTING (3)
- 415. THEATRE ORGANIZATION AND MANAGEMENT (3)
- 421. ADVANCED PLAYWRITING (3)
- 431. HISTORY OF THE THEATRE (3)
- 442. CREATIVE DRAMATICS WITH CHILDREN (3)
- 443. MARIONETTES AND PUPPETRY (3)
- 451. DIRECTING (3)
- 452. CENTRAL STAGING (3)
- 470. THEATRE PRODUCTION (3)
- 480. RADIO DRAMA (3)
- 481. ADVANCED RADIO DRAMA (3)
  
- 501. PROBLEMS OF DIRECTING (3-6) Seminar in problems of production with particular stress on direction. Students will direct plays under staff supervision.
- 502. SEMINAR IN THE TECHNICAL PROBLEMS OF DRAMATIC PRODUCTION (3-6) Prerequisite: Thea. 11.
- 504. SEMINAR IN STYLES OF ACTING (3-6) Practical work required of each student.
- 506. EVALUATION AND APPRECIATION OF MODERN DRAMATIC ENTERTAINMENT (3)  
Prerequisites: Thea. 1, 61.
- 507. SEMINAR IN FUNDAMENTAL THEORIES OF THEATRE AND DRAMA (3-6)
- 521. PLAYWRITING (3-6) Prerequisites: Thea. 21, 421.

## WILDLIFE MANAGEMENT

*Consult* BERTIL G. ANDERSON  
212 Frear Laboratory

The M.S. degree is offered in the field of wildlife management. Candidates select courses for this major from a number of related fields.

## ZOOLOGY

BERTIL G. ANDERSON  
*Head of the Department of Zoology and Entomology*  
212 Frear Laboratory

The Department of Zoology and Entomology offers work leading to the M.S. and Ph.D. degrees with a major in zoology. Students may specialize in animal behavior,



bioacoustics, ecology, endocrinology, fishery biology, genetics, histology, ichthyology, invertebrate zoology, invertebrate physiology, or wildlife management.

In order to undertake graduate work in zoology, students are required to have had 24 credits in zoology and related biological sciences; and they should have had chemistry through organic chemistry. Courses in physics and mathematics are also advantageous. A limited deficiency can be made up without degree credit while pursuing graduate work.

## ZOOLOGY (ZOOLOGY)

- |                                                                     |                                           |
|---------------------------------------------------------------------|-------------------------------------------|
| 401. (P.H. 401, Psy. 401). ANIMAL BEHAVIOR (3)                      | <i>Mr. Hale</i>                           |
| 405. (Bot. 405). GENERAL CYTOLOGY (3)                               | <i>Mr. Grun</i>                           |
| 408. MAMMALOGY (4)                                                  |                                           |
| 410. GENERAL LIMNOLOGY (3)                                          | <i>Mr. Cooper</i>                         |
| 415. THE LITERATURE OF ZOOLOGY (1)                                  | <i>Mr. B. G. Anderson</i>                 |
| 416. THE METHODS OF RESEARCH IN ZOOLOGY (2)                         | <i>Mr. B. G. Anderson</i>                 |
| 417. INVERTEBRATE ZOOLOGY (3)                                       | <i>Mr. Frings</i>                         |
| 419. GENERAL ANIMAL ECOLOGY (3)                                     | <i>Mr. Bellis</i>                         |
| 420. GAME BIRDS (3)                                                 |                                           |
| 421. COMPARATIVE ANATOMY OF VERTEBRATES (4)                         |                                           |
| 422. (Bot. 422). ADVANCED GENETICS (3)                              | <i>Mr. Wright</i>                         |
| 432. HUMAN PARASITOLOGY (3)                                         |                                           |
| 433. (Bot. 433). GENETICS, EUGENICS, AND EVOLUTION FOR TEACHERS (3) | <i>Messrs. Wright, Grun, and Mitchell</i> |
| 436. PROTOZOOLOGY (3)                                               |                                           |
| 437. HISTOLOGY (4)                                                  | <i>Mr. Anthony</i>                        |
| 440. EMBRYOLOGY (4)                                                 |                                           |
| 441. ESSENTIALS OF HUMAN PHYSIOLOGY FOR TEACHERS (3)                | <i>Mr. Tietz</i>                          |
| 444. ZOOLOGICAL PROBLEMS (1-6)                                      |                                           |
| 448. ORNITHOLOGY (3)                                                | <i>Mr. Wood</i>                           |
| 450. ICHTHYOLOGY (4)                                                | <i>Mr. Cooper</i>                         |
| 461. ANIMAL PARASITOLOGY (3)                                        |                                           |
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505. (Bot. 505). CYTOLOGY AND CYTOGENETICS (3) Chromosome mechanism of heredity; relationship between plant and animal evolution and breeding and changes in chromosomes; cytological and cytochemical techniques. Prerequisite: Bot. or Zool. 405 or 422. Fall semester, even years. *Mr. Grun*
508. ADVANCED PARASITOLOGY (3) Advanced work on the structure, life cycle, and control of parasites.
509. TECHNIQUES IN WILDLIFE MANAGEMENT (3) Preparing study mounts, census making, management area mapping, methods of collecting data, and determining food habits from stomach contents. Prerequisite: Zool. 546. Spring semester.
512. SEMINAR (1) Review of current zoological literature. Required of graduate students majoring in zoology and entomology. Prerequisite: 12 credits in zoology or entomology.
514. SPECIAL TOPICS IN ZOOLOGY (3) Individual problems in any field of zoology, with or without experimental work. Prerequisite: Zool. 26.
524. (Bot. 524). SEMINAR IN GENETICS (1 per semester) *Mr. Wright*

## ZOOLOGY

528. (Bot. 528). **POPULATION GENETICS (3)** Factors affecting gene frequency, genotype frequency, genotype-environmental interaction, and genetic relationship in natural and artificial populations. Fall semester, odd years. *Mr. Mitchell*
533. (Bot. 533). **PROBLEMS IN GENETICS (2-6)** Problems to suit needs of individual students; conferences and laboratory work. Prerequisite: Bot. or Zool. 422. *Messrs. Wright, Grun, and Mitchell*
537. (Bot. 537, Ed. 537). **WORKSHOP IN THE BIOLOGICAL SCIENCES (3)** Projects designed for teachers of biology in the secondary schools. Summer sessions.
541. **COMPARATIVE PHYSIOLOGY (3)** Dynamics of vital processes as shown in members of the animal kingdom. Prerequisites: Zool. 26; A.B.Ch. 1; A.B.Ch. 425 or Zool. 437. Spring semester. *Mr. Frings*
546. **THE THEORY OF GAME MANAGEMENT (4)** Fundamental principles underlying management of wild game birds and mammals; co-ordination of such management with various land uses; planning preserves and other land areas. Prerequisites: Zool. 408, 420. Fall semester.
551. **FISHERIES MANAGEMENT (3)** Basic principles underlying management of inland waters for fish production. Prerequisite: Zool. 450. Spring semester, odd years.
581. **ADVANCED INVERTEBRATE ZOOLOGY (3)** Morphology, physiology, taxonomy, and life histories of invertebrae animals. Fall semester, even years. *Mr. Frings*
582. (P.H. 582, Psy 582). **RESEARCH IN ANIMAL BEHAVIOR (2-6 per semester)** Research in special areas of animal behavior involving field and laboratory work. Prerequisite: Zool., P.H., or Psy. 401; or Psy. 403. *Messrs. Hale and Schein*
583. **GENERAL ENDOCRINOLOGY (2)** Anatomy and physiology of the organs of internal secretion; role of hormones in metabolism and development. Spring semester, odd years. *Mr. Anthony*
587. **BIOLOGY OF SEX (2)** Hereditary and embryological aspects, problems in gonadal differentiation, cyclic reproductive phenomena, actions of the hormones. Spring semester, even years. *Mr. Anthony*

## *Part II*

### *Other Elective Graduate Courses*

The following courses involve fields in which neither major nor minor work is offered at this institution. The courses, however, carry graduate credit and, with the approval of the major department, may be applied toward the requirements for a degree either as elective courses or as a part of a general studies program. The usual restrictions upon the use of 400 series courses in degree programs apply to these courses.

#### AGRICULTURE, GENERAL (AG)

400. INTRODUCTORY BIOMETRY (3)

#### ASTRONOMY (ASTRO)

470. SOLAR PHYSICS (3)

486. ASTRONOMICAL PHOTOGRAPHY (3)

490-491. INTRODUCTION TO ASTROPHYSICS (3 each)

#### COMMERCIAL CONSUMER SERVICES (C C S)

403. LECTURE-DEMONSTRATION TECHNIQUES (3)

*Miss Allgood*

450. PROBLEMS IN HOUSEHOLD EQUIPMENT (1-6)

*Miss Allgood*

#### ENGINEERING (ENGR)

410. NUCLEAR ENGINEERING (3)

411. NUCLEAR ENGINEERING (3)

422. ORDNANCE ENGINEERING: TORPEDO ENGINEERING (3)

430. INTRODUCTION TO DIGITAL COMPUTER PROGRAMMING (1)

431. DIGITAL COMPUTER PROGRAMMING (3)

450. PATENT FUNDAMENTALS (3)

500. SPECIAL TOPICS IN ENGINEERING (1-3)

501. REACTOR ENGINEERING (3) Reactor controls, shielding of nuclear reactors, stress analysis of reactor materials, power cycle analysis, breeding, and advanced design considerations. Prerequisite or concurrent: Phys. 566.

502. REACTOR ENGINEERING LABORATORY (1) Reactor experiments devised to acquaint the student with reactor technology. Prerequisite or concurrent: Phys. 566.

531. ADVANCED DIGITAL COMPUTER PROGRAMMING (3) Programming for commercial computers; programming techniques; numerical methods for computers; solution of problems on the Penn State Digital Computer. Prerequisites: Math. 405, Engr. 431.

#### GREEK (GREEK)

421. GREEK TRAGEDY (3)

*Mr. Will*

422. GREEK COMEDY (3)

*Mr. Will*

423. ATTIC ORATORS (3)

*Mr. Will*



## GREEK

427. NEW TESTAMENT GREEK (3) *Mr. Will*
500. GREEK COMPOSITION (2) Translation of extended narrative passages into Attic Greek; thorough review of forms and syntax; attention to rhetorical elements of the language. *Mr. Will*

## HEALTH EDUCATION (HL ED)

403. FIRST AID, ATHLETIC CONDITIONING AND TRAINING (3)
406. RECENT DEVELOPMENTS IN SCHOOL HEALTH EDUCATION (3)
407. ADVANCED PERSONAL AND PUBLIC HEALTH (3)
411. PRINCIPLES AND METHODS OF TEACHING SAFETY EDUCATION (3)
427. HEALTH FACTORS IN THE DEVELOPMENT OF THE ADOLESCENT (3)
453. ORGANIZATION AND ADMINISTRATION OF HEALTH EDUCATION (3)
456. ADVANCED TECHNIQUES IN RURAL SCHOOL HEALTH (3)
501. HEALTH IMPLICATIONS IN THE GROWTH AND DEVELOPMENT OF SCHOOL CHILDREN (3) Child growth and development emphasis for teachers; medical inspection and examination; preschool program; early habit formations; behavior problems; co-operation of parents, teachers, and children. Prerequisite: Hl.Ed. 215.
505. ADVANCED TECHNIQUES IN HEALTH EDUCATION (3) Prerequisites: Hl.Ed. 215, 399, Psy. 437.
572. TESTS AND MEASUREMENTS IN HEALTH EDUCATION (3) Critical study, evaluation, and demonstration of tests and measures of health education; statistical computations of data. Prerequisites: Ph.Ed. 490, Hl.Ed. 215, 399.

## HOME-COMMUNITY RELATIONSHIPS (H C R)

499. INTERCULTURAL STUDIES IN HOME ECONOMICS (2-6)
- 502, 502v. HOME ECONOMICS AND AMERICAN SOCIETY (3) Family life education in relation to a democratic culture; emphasis upon the interrelatedness of socioeconomic problems and the American family.
503. GRADUATE SEMINAR IN HOME ECONOMICS (1) *Miss Henderson*

## INTERNATIONAL UNDERSTANDING (INT U)

400. WORLD AFFAIRS AND INTERNATIONAL UNDERSTANDING (3-6)

## LATIN (LATIN)

428. LUCRETIUS (3) *Mr. Krauss*
429. QUINTILIAN (3) *Mr. Krauss*
431. JUVENAL (3) *Mr. Krauss*
436. FUNCTIONAL PROBLEMS IN LATIN (3)
500. LATIN LITERATURE (3) Lectures and collateral readings on the major forms of Latin literature; readings in the original Latin to supplement the lectures. *Mr. Krauss*
501. ROMAN RELIGION AND PHILOSOPHY (3) Development of religious concepts at Rome from primitive Italic origins to the advanced forms that culminated in Roman Stoicism. *Mr. Krauss*

502. LATIN EPIGRAPHY (3) Lectures and readings on Roman inscriptions; illustrative exercises. *Mr. Krauss*

503. LATIN PALEOGRAPHY (3) The Latin alphabet, writing materials, Roman book and cursive hands; illustrative exercises. *Mr. Krauss*

504. ROMAN TOPOGRAPHY (3) Physical development of the city of Rome, its walls, aqueducts, bridges, streets, forums, public buildings, temples, etc.; building materials and methods of construction. *Mr. Krauss*

510. LATIN SEMINAR (3) *Mr. Krauss*

518. LATIN RESEARCH (1-3) Prosecution of an assigned problem under the guidance of a member of the department.

#### LIBERAL ARTS (L A)

500-501. FUNDAMENTALS OF LINGUISTICS (3 each) Interrelated problems of language discussed from four points of view: modern structural linguistics, historical linguistics, social psychology, and philosophy.

#### LIBRARY SCIENCE (L SC)

403. INTERMEDIATE DICTIONARY CATALOGING AND SUBJECT HEADINGS (3)

405. INTERMEDIATE REFERENCE WORK AND BIBLIOGRAPHY (3)

407. SPECIAL PROBLEMS IN SCHOOL LIBRARY SERVICE (6)

#### MINERAL INDUSTRIES (MN I)

400. MINERAL INDUSTRIES IN MODERN CIVILIZATION (3)

#### MINERAL SCIENCES (MN SC)

411. INSTRUMENT TECHNIQUES APPLIED TO MINERAL SCIENCE PROBLEMS (1-3)

*Unit A. X-Ray Diffraction*

*Unit B. Electron Microscopy*

*Unit C. Spectroscopy*

510. X-RAY AND ELECTRON DIFFRACTION ANALYSIS AS APPLIED TO MINERALS AND METALS (2) Prerequisite: Phys. 285. *Mr. Brindley*

520. ELECTRON MICROSCOPY IN MINERAL SCIENCE RESEARCH (1-4) Prerequisite: Mn.Sc. 411, Unit B. *Messrs. Bates and Comer*

530. SPECTROSCOPY IN MINERAL SCIENCE RESEARCH (1-4) Prerequisite: Mn.Sc. 411, Unit C. *Mr. Lovell*

540. SOLID STATE STRUCTURES AND REACTIONS IN MINERAL SYSTEMS (2-4) Crystal chemical approach to solid state reactions, sintering, melting, hardness, thermal expansion, and behavior of matter under high pressure. *Mr. Weyl*

#### NATURE EDUCATION (NA ED)

401. TRAINING IN NATURE FOR CAMP COUNSELORS (3)

#### RELIGIOUS STUDIES (RL ST)

401. RELIGIOUS PHILOSOPHY OF THE GREAT REFORMERS (3)

## *RUSSIAN*

### **RUSSIAN (RUS)**

401. STUDIES IN RUSSIAN LITERATURE (3-6)

425. PUSHKIN (3)

426. DOSTOEVSKI (3)

427. TOLSTOY (3)

### **VETERINARY SCIENCE (V SC)**

400. VETERINARY ANATOMY AND PHYSIOLOGY (3)

401. INFECTIOUS DISEASES OF DOMESTIC ANIMALS (2)

515. (Bact. 515). VIROLOGY (2-4) Rickettsial and viral agents parasitizing man, animals, and microorganisms. Prerequisite: Bact. 410.



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**The  
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State  
University  
Bulletin**

**GRADUATE**

**DEGREE PROGRAMS**

**Volume II**

**General Catalog Issue**

**1961**

**1960**

OFFICE OF THE GRADUATE SCHOOL  
104 WILLARD BUILDING

The post office address of The Pennsylvania State University is University Park, Pennsylvania, but the town in which the University is located is State College.

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UNIVERSITY PARK, PENNSYLVANIA



The  
Pennsylvania  
State  
University

General  
Catalog



1960-1961

Volume II

Graduate  
Degree  
Programs

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# \* GRADUATE CALENDAR

## SPRING SEMESTER 1960

### FEBRUARY 1960

- 3-6 Wednesday to Saturday Noon—Spring Semester Registration
- 3-6 Wednesday to Saturday Noon—Oral Examinations in Foreign Languages for Doctoral Candidates
- 8 Monday—Spring Semester Classes Begin 8 a.m.
- 8 Monday—Last Date for Registering with Foreign Language Departments for Written Language Examinations
- 20 Saturday—Last Date for Adding Courses to Approved Schedules
- 25 Thursday—Graduate Faculty Meeting 4:10 p.m.

### MARCH

- 5 Saturday—Last Date for Dropping Courses from Approved Schedules
- 7 Monday—Written Foreign Language Examinations for Doctoral Candidates 7 p.m.
- 19 Saturday—Last Date for Paying Thesis Binding Fees and for Informing Recorder of Intention to Graduate in June
- 24 Thursday—Graduate Faculty Meeting 4:10 p.m.

### APRIL

- 13 Wednesday—Spring Recess Begins 11:50 a.m.
- 21 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 20 Wednesday—Spring Recess Ends 12:15 p.m.

### MAY

- 14 Saturday—Last Date for a June Graduate to Deliver Doctoral Thesis to Committee
- 19 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 21 Saturday—Last Date for a June Graduate to Deliver Master's Thesis to Adviser
- 21 Saturday—Last Date for Final Oral Doctoral Examination for a June Graduate
- 21 Saturday—Cap and Gown Fee Due 5:30 p.m.
- 26 Thursday—Spring Semester Classes End 9:50 p.m.
- 27 Friday—Free Day to Prepare for Examinations
- 28 Saturday—Spring Semester Examinations Begin 8 a.m.
- 28 Saturday—Last Date for Submitting a Petition to Graduate in Absentia in June
- 28 Saturday—Theses Due in Graduate School Office 12 noon

### JUNE

- 6 Monday—Spring Semester Ends 9:50 p.m.
- 11 Saturday—Spring Semester Commencement

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\*This calendar was approved June 15, 1959. It is subject to change without notice.



## SUMMER SESSIONS 1960

### JUNE 1960

- 13 Monday—Registration for Inter-Session in a.m.
- 13 Monday—Registration for First Six Weeks Session in p.m.
- 13 Monday—Inter-Session Classes Begin 2 p.m.
- 14 Tuesday—First Six Weeks Session Classes Begin 8 a.m.
- 15 Wednesday—Last Date for Inter-Session Students to Drop or Add Courses
- 20 Monday—Last Date for First Six Weeks Session Students to Drop or Add Courses

### JULY

- 1 Friday—Inter-Session Ends 6:20 p.m.
- 4 Monday—Independence Day Recess
- 5 Tuesday—Registration for Mid-Session
- 6 Wednesday—Mid-Session Classes Begin 8 a.m.
- 6 Wednesday—Oral Examinations in Foreign Languages and Registration for Written Examinations for Doctoral Candidates
- 11 Monday—Last Date for Mid-Session Students to Drop or Add Courses
- 15 Friday—Last Date for an August Graduate to Deliver Doctoral Thesis to Committee
- 15 Friday—Last Date for Paying Thesis Binding Fees and for Informing Recorder of Intention to Graduate in August
- 22 Friday—Last Date for an August Graduate to Deliver Master's Thesis to Adviser
- 22 Friday—Last Date for Final Oral Doctoral Examination for an August Graduate
- 22 Friday—First Six Weeks Session Ends 6:20 p.m.
- 23 Saturday—Cap and Gown Fee Due 5:30 p.m.
- 25 Monday—Registration for Second Six Weeks Session in a.m.
- 25 Monday—Second Six Weeks Session Classes Begin 2 p.m.
- 29 Friday—Theses Due in Graduate School Office 5 p.m.
- 29 Friday—Last Date for Submitting a Petition to Graduate in Absentia in August

### AUGUST

- 1 Monday—Last Date for Second Six Weeks Session Students to Drop or Add Courses
- 1 Monday—Written Foreign Language Examinations for Doctoral Candidates 7 p.m.
- 12 Friday—Mid-Session Ends 6:20 p.m.
- 12 Friday—Mid-Session Commencement 7 p.m.
- 15 Monday—Registration for Post-Session in a.m.
- 15 Monday—Post-Session Classes Begin 2 p.m.
- 17 Wednesday—Last Date for Post-Session Students to Drop or Add Courses

### SEPTEMBER

- 2 Friday—Post-Session and Second Six Weeks Session End 6:20 p.m.

## *FALL SEMESTER 1960*

### **SEPTEMBER 1960**

- 14-17 Wednesday to Saturday Noon—Fall Semester Registration
- 14-17 Wednesday to Saturday Noon—Oral Examinations in Foreign Languages for Doctoral Candidates
- 19 Monday—Fall Semester Classes Begin 8 a.m.

### **OCTOBER**

- 1 Saturday—Last Date for Adding Courses to Approved Schedules
- 3 Monday—Last Date for Registering with Foreign Language Departments for Written Language Examinations
- 15 Saturday—Last Date for Dropping Courses from Approved Schedules
- 20 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 29 Saturday—Last Date for Paying Thesis Binding Fees and for Informing Recorder of Intention to Graduate in January

### **NOVEMBER**

- 7 Monday—Written Foreign Language Examinations for Doctoral Candidates 7 p.m.
- 17 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 22 Tuesday—Thanksgiving Recess Begins 9:50 p.m.
- 28 Monday—Thanksgiving Recess Ends 8 a.m.

### **DECEMBER**

- 15 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 21 Wednesday—Christmas Recess Begins 11:50 a.m.
- 31 Saturday—Last Date for a January Graduate to Deliver Doctoral Thesis to Committee

### **JANUARY 1961**

- 4 Wednesday—Christmas Recess Ends 12:15 p.m.
- 7 Saturday—Last Date for a January Graduate to Deliver Master's Thesis to Adviser
- 7 Saturday—Last Date for Final Oral Doctoral Examination for a January Graduate
- 7 Saturday—Cap and Gown Fee Due 5:30 p.m.
- 14 Saturday—Last Date for Submitting a Petition to Graduate in Absentia in January
- 14 Saturday—Theses Due in Graduate School Office 12 noon
- 17 Tuesday—Fall Semester Classes End 9:50 p.m.
- 18 Wednesday—Free Day to Prepare for Examinations
- 19 Thursday—Fall Semester Examinations Begin 8 a.m.
- 27 Friday—Fall Semester Ends 9:50 p.m.
- 28 Saturday—Fall Semester Commencement

## *SPRING SEMESTER 1961*

### **FEBRUARY 1961**

- 1-4 Wednesday to Saturday Noon—Spring Semester Registration
- 1-4 Wednesday to Saturday Noon—Oral Examinations in Foreign Languages for Doctoral Candidates

- 6 Monday—Spring Semester Classes Begin 8 a.m.
- 6 Monday—Last Date for Registering with Foreign Language Departments for Written Language Examinations
- 16 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 18 Saturday—Last Date for Adding Courses to Approved Schedules

### MARCH

- 4 Saturday—Last Date for Dropping Courses from Approved Schedules
- 6 Monday—Written Foreign Language Examinations for Doctoral Candidates 7 p.m.
- 16 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 18 Saturday—Last Date for Paying Thesis Binding Fees and for Informing Recorder of Intention to Graduate in June
- 29 Wednesday—Spring Recess Begins 11:50 a.m.

### APRIL

- 5 Wednesday—Spring Recess Ends 12:15 p.m.
- 20 Thursday—Graduate Faculty Meeting 4:10 p.m.

### MAY

- 13 Saturday—Last Date for a June Graduate to Deliver Doctoral Thesis to Committee
- 18 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 20 Saturday—Last Date for Final Oral Doctoral Examination for a June Graduate
- 20 Saturday—Last Date for a June Graduate to Deliver Master's Thesis to Adviser
- 20 Saturday—Cap and Gown Fee Due 5:30 p.m.
- 25 Thursday—Spring Semester Classes End 9:50 p.m.
- 26 Friday—Free Day to Prepare for Examinations
- 27 Saturday—Spring Semester Examinations Begin 8 a.m.
- 27 Saturday—Theses Due in Graduate School Office 12 Noon
- 27 Saturday—Last Date for Submitting a Petition to Graduate in Absentia in June

### JUNE

- 5 Monday—Spring Semester Ends 9:50 p.m.
- 10 Saturday—Spring Semester Commencement



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# GRADUATE FACULTY 1959-60

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VERNON M. ALBERS, Ph.D. (Illinois)	<i>Engineering Research</i>
JOHN O. ALMQUIST, Ph.D. (Penn State)	<i>Dairy Physiology</i>
PAUL M. ALTHOUSE, Ph.D. (Penn State)	<i>Agricultural and Biological Chemistry</i>
EDGAR E. AMBROSIUS, M.S. (Illinois), P.E.	<i>Mechanical Engineering</i>
BERTIL G. ANDERSON, Ph.D. (Iowa)	<i>Zoology</i>
EDWIN J. ANDERSON, M.S. (Cornell)	<i>Apiculture</i>
JOHN M. ANDERSON, Ph.D. (California)	<i>Philosophy</i>
FRANCES M. ANDREWS, D.Ed. (Penn State)	<i>Music Education</i>
JOHN G. ASTON, Ph.D. (California)	<i>Organic Chemistry</i>
ESTHER A. ATKINSON, M.S. (Kansas State)	<i>Hotel and Institution Administration</i>
ELTON ATWATER, Ph.D. (American U.)	<i>Political Science</i>
RUTH W. AYRES, Ph.D. (Brookings)	<i>Clothing and Textiles</i>
RALPH L. BAKER, Ph.D. (Iowa State)	<i>Marketing</i>
WILLIAM L. BARR, Ph.D. (Cornell)	<i>Farm Management</i>
THOMAS F. BATES, Ph.D. (Columbia)	<i>Mineralogy</i>
CLARE A. BECKER, Ph.D. (Cornell)	<i>Agricultural Business Management</i>
F. JOSEPH BEDENK, M.A. (Columbia)	<i>Physical Education</i>
MAURICE E. BELL, Ph.D. (M.I.T.)	<i>Geophysics</i>
KENNETH R. BENNETT, Ph.D. (Cornell)	<i>Agricultural Statistics</i>
THOMAS C. BENTON, Ph.D. (Pennsylvania)	<i>Mathematics</i>
JESSIE BERNARD, Ph.D. (Washington U.)	<i>Sociology</i>
ROBERT G. BERNREUTER, Ph.D. (Stanford)	<i>Psychology</i>

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PAUL W. BIXBY, Ed.D. (Columbia)	Education
ALEX BLACK, Ph.D. (Rochester)	Animal Nutrition
NORRIS D. BLACKBURN, Ph.D. (Ohio State)	Entomology
HOWARD J. BONSER, Ph.D. (Penn State)	Rural Sociology Extension
ALFRED L. BORTREE, D.V.M. (Michigan State)	Veterinary Science
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THOMAS D. BOWMAN, M.A. (Penn State)	English Literature
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JOHN W. BRATZLER, Ph.D. (Cornell)	Animal Nutrition
ARTHUR H. BRAYFIELD, Ph.D. (Minnesota)	Psychology
GLENN O. BRESSLER, Ph.D. (Cornell)	Poultry Husbandry
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FERDINAND G. BRICKWEDDE, Ph.D. (Johns Hopkins)	Chemistry and Physics
GEORGE W. BRINDLEY, Ph.D. (Leeds)	Solid State Technology
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CHARLES H. BROWN, M.A. (Oklahoma)	Journalism
HUGH S. BROWN, Ph.D. (Minnesota)	Education
WILHELM R. BUESSEM, Dr. Ing. (Technical University, Berlin)	Ceramic Technology
ALBERT F. BUFFINGTON, Ph.D. (Harvard)	German
MICHAEL R. CANNON, Ph.D. (Penn State), P.E.	Chemical Engineering
HOWARD L. CARNAHAN, Ph.D. (Minnesota)	Agronomy
CLARENCE R. CARPENTER, Ph.D. (Stanford)	Psychology
H. BEECHER CHARMBURY, Ph.D. (Penn State)	Mineral Preparation
TIEN-HSI CHENG, Ph.D. (Ohio State)	Zoology
CARL O. CLAGETT, Ph.D. (Wisconsin)	Agricultural and Biological Chemistry
ROBERT E. CLARK, Ph.D. (Chicago)	Sociology
TERESA COHEN, Ph.D. (Johns Hopkins)	Mathematics
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DAVID E. DAVIS, Ph.D. (Harvard)	Zoology
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*Music*  
*Soil Technology*  
*Pomology*  
*Home Economics*



## P R O F E S S O R S

BENJAMIN F. HOWELL, JR., Ph.D. (California Tech.), P.E.	<i>Geophysics</i>
FLOYD A. HUMMEL, M.S. (Penn State)	<i>Ceramic Technology</i>
MERWIN W. HUMPHREY, M.F. (Yale)	<i>Forestry</i>
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A. WITT HUTCHISON, Ph.D. (Penn State)	<i>Chemistry</i>
ROBERT F. HUTTON, Ph.D. (Harvard)	<i>Farm Management</i>
FRANCIS E. HYLSON, JR., M.F.A. (Princeton)	<i>History of Art and Architecture</i>
LOIS B. HYSLOP, Ph.D. (Wisconsin)	<i>Romance Languages</i>
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MACKLIN E. JOHN, Ph.D. (Cornell)	<i>Rural Sociology</i>
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FRANK A. JOY, B.S. (New Hampshire)	<i>Engineering Research</i>
LOUIS T. KARDOS, Ph.D. (Rutgers)	<i>Soil Technology</i>
MACKENZIE L. KEITH, Ph.D. (M.I.T.)	<i>Geochemistry</i>
PAUL M. KENDIG, Ph.D. (Penn State)	<i>Engineering Research</i>
CORLISS R. KINNEY, Ph.D. (Harvard)	<i>Fuel Technology</i>
PHILIP S. KLEIN, Ph.D. (Pennsylvania)	<i>American History</i>
HENRY W. KNERR, Ph.D. (Michigan)	<i>Physics</i>
R. RUPERT KOUNTZ, M.S. (Iowa), P.E.	<i>Sanitary Engineering</i>
HARRY L. KRALL, Ph.D. (Brown)	<i>Mathematics</i>
FRANKLIN B. KRAUSS, Ph.D. (Pennsylvania)	<i>Latin</i>
DAVID A. KRIBS, Ph.D. (Yale)	<i>Botany</i>
PAUL D. KRYNINE, Ph.D. (Yale)	<i>Petrology and Sedimentation</i>
OTIS E. LANCASTER, Ph.D. (Harvard), P.E.	<i>Engineering Education</i>
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RUSSELL E. LARSON, Ph.D. (Minnesota)	<i>Horticulture</i>
JOHN D. LAWTHOR, M.A. (Columbia), D.Pd.	<i>Physical Education</i>
WAYNE A. LEE, Ph.D. (Cornell)	<i>Marketing</i>
WILLIAM M. LEPLEY, Ph.D. (Penn State)	<i>Psychology</i>
LAURENT LESAGE, Ph.D. (Illinois)	<i>Romance Languages</i>
FRED H. LEWIS, Ph.D. (Cornell)	<i>Plant Pathology</i>
ROBERT W. LINDSAY, D.Sc. (M.I.T.)	<i>Metallurgy</i>
JESSE E. LIVINGSTON, Ph.D. (Missouri)	<i>Botany and Plant Pathology</i>
A. PAULINE LOCKLIN, M.A. (Illinois)	<i>English</i>
CHARLES M. LONG, D.Ed. (Colorado)	<i>Education</i>
GEORGE M. LOTT, M.D. (Colorado)	<i>Psychiatrist</i>
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VIKTOR LOWENFELD, Professor der Kunsterziehung (Vienna)	<i>Art Education</i>
ERNEST H. LUDWIG, Ph.D. (Pennsylvania)	<i>Bacteriology</i>
JOHN C. MAJOR, Ph.D. (Pennsylvania)	<i>English Composition</i>
FREDERICK B. MARBUT, Ph.D. (Harvard)	<i>Journalism</i>
PAUL H. MARGOLF, B.S. (Penn State)	<i>Poultry Husbandry</i>
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ROBERT E. MCDERMOTT, Ph.D. (Duke)	<i>Forestry</i>
EUGENE T. McDONALD, D.Ed. (Penn State)	<i>Speech and Speech Education</i>
DONALD G. MCGAREY, D.Ed. (Penn State)	<i>Education</i>
M. NELSON MCGEARY, Ph.D. (Columbia)	<i>Political Science</i>
DAVID H. MCKINLEY, M.A. (Penn State), LL.B.	<i>Banking</i>
DOUGLASS S. MEAD, Ph.D. (Princeton)	<i>English Literature</i>
ROBERT P. MEAHL, M.S. (Purdue)	<i>Ornamental Horticulture</i>
JOHN R. MENTZER, Ph.D. (Ohio State)	<i>Engineering Sciences</i>
WOLFGANG E. MEYER, Dipl.Ing.M.E. (Hannover)	<i>Mechanical Engineering</i>
IRVING MICHELSON, Ph.D. (California Tech.)	<i>Aeronautical Engineering</i>
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WARREN W. MILLER, Ph.D. (California)	<i>Chemistry</i>
WILFORD R. MILLS, Ph.D. (Cornell)	<i>Plant Pathology</i>
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WINONA L. MORGAN, Ph.D. (Minnesota)	<i>Child Development and Family Relationships</i>
JOHN A. MOURANT, Ph.D. (Chicago)	<i>Philosophy</i>
JAMES H. MOYER, D.Ed. (Columbia)	<i>Education</i>
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GEORGE E. MURPHY, D.Ed. (Stanford)	<i>Education</i>
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G. KENNETH NELSON, Ph.D. (Illinois), C.P.A.	<i>Accounting</i>
MARGARET A. NEUBER, M.A. (Columbia)	<i>Education</i>
HANS NEUBERGER, D.Sc. (Hamburg)	<i>Meteorology</i>
FRANK S. NEUSBAUM, M.A. (Penn State)	<i>Theatre Arts</i>
BENJAMIN W. NIEBEL, M.S. (Penn State), I.E., P.E.	<i>Industrial Engineering</i>
RALPH F. NIELSEN, Ph.D. (Nebraska)	<i>Petroleum and Natural Gas Engineering</i>
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THOMAS S. OAKWOOD, Ph.D. (Penn State)	<i>Chemistry</i>
MARTIN L. ODLAND, Ph.D. (Minnesota)	<i>Olericulture</i>
ROBERT T. OLIVER, Ph.D. (Wisconsin), LL.D.	<i>Speech</i>
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NUNZIO J. PALLADINO, M.S. (Lehigh), P.E.	<i>Nuclear Engineering</i>
HANS A. PANOFSKY, Ph.D. (California)	<i>Meteorology</i>
ROBERT B. PATRICK, D.Ed. (Columbia)	<i>Education</i>
LOUIS F. PECK, Ph.D. (Harvard)	<i>English Composition</i>
FRANK W. PEIKERT, M.S. (Iowa State)	<i>Agricultural Engineering</i>
RAYMOND PEPINSKY, Ph.D. (Chicago)	<i>Physics</i>
LAWRENCE J. PEREZ, M.C.E. (Brooklyn Polytech.), P.E.	<i>Civil Engineering</i>
CLARE W. PIERCE, Ph.D. (Cornell)	<i>Agricultural Economics</i>
GORDON H. PRITHAM, Ph.D. (Penn State)	<i>Physiological Chemistry</i>
ALFRED G. PUNDT, Ph.D. (Columbia)	<i>European History</i>

## P R O F E S S O R S

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DOROTHY QUIGGLE, Ph.D. (Penn State)	<i>Chemistry and Chemical Engineering</i>
JOHN R. RACKLEY, Ph.D. (George Peabody)	<i>Education</i>
STEPHEN M. RALEIGH, Ph.D. (Minnesota)	<i>Agronomy</i>
DAVID H. RANK, Ph.D. (Penn State), D.Sc.	<i>Physics</i>
JOSEPH G. RAYBACK, Ph.D. (Western Reserve)	<i>American History</i>
HAROLD J. READ, Ph.D. (Pennsylvania), P.E.	<i>Physical Metallurgy</i>
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JAMES J. REID, Ph.D. (Wisconsin)	<i>Bacteriology</i>
J. W. CRANE REMALEY, Ph.D. (Pittsburgh)	<i>Education</i>
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WILLIAM U. SNYDER, Ph.D. (Ohio State)	<i>Psychology</i>
HERMAN M. SOUTHWORTH, A.B. (Cornell)	<i>Agricultural Economics</i>
NORMAN R. SPARKS, M.E. (Clarkson)	<i>Mechanical Engineering</i>
CHARLES M. SPEIDEL, M.S. (Penn State)	<i>Physical Education</i>
THEODORE S. SPICER, Fuels Eng. (Penn State), P.E.	<i>Fuel Technology</i>
HOWARD B. SPRAGUE, Ph.D. (Rutgers)	<i>Agronomy</i>
VANCE G. SPRAGUE, Ph.D. (Wisconsin)	<i>Agronomy</i>
GLENN Z. STEVENS, Ph.D. (Minnesota)	<i>Agricultural Education</i>
ROBERT W. STONE, Ph.D. (Iowa State)	<i>Bacteriology</i>
RANDALL S. STOUT, Ph.D. (Pittsburgh)	<i>Economics</i>
EARL P. STRONG, Ed.D. (N.Y.U.)	<i>Management</i>
JOSEPH T. SULLIVAN, Ph.D. (Purdue)	<i>Phytochemistry</i>
SHIOU-CHUAN SUN, Sc.D. (M.I.T.)	<i>Mineral Preparation</i>
A. BRUCE SUTHERLAND, Ph.D. (Pennsylvania)	<i>English Literature</i>



## PROFESSORS

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RAYMOND W. SWIFT, Ph.D. (Rochester)	<i>Animal Nutrition</i>
ROBERT W. TAFT, JR., Ph.D. (Ohio State)	<i>Chemistry</i>
SHELDON C. TANNER, M.A. (Utah)	<i>Business Law</i>
HAROLD I. TARPLEY, M.S. (Illinois), P.E.	<i>Electrical Engineering</i>
WILLA C. TAYLOR, M.A. (N.Y.U.)	<i>Music and Music Education</i>
GLENN N. THIEL, M.Ed. (Penn State)	<i>Physical Education</i>
S. EARL THOMPSON, D.Ed. (Illinois)	<i>Hotel and Institution Administration</i>
GEORGE L. THUERING, M.S. (Penn State), M.E., P.E.	<i>Industrial Engineering</i>
HARRISON M. TIETZ, Ph.D. (Massachusetts)	<i>Anatomy and Physiology</i>
HOWARD O. TRIEBOLD, Ph.D. (Minnesota)	<i>Agricultural and Biological Chemistry</i>
O. FRANK TUTTLE, Ph.D. (M.I.T.)	<i>Geochemistry</i>
ABRAM W. VANDERMEER, Ph.D. (Chicago)	<i>Education</i>
EDWARD B. VANORMER, Ph.D. (Columbia)	<i>Psychology</i>
DOROTHY H. VEON, Ed.D. (Columbia)	<i>Education</i>
ROBERT K. VIERCK, M.S. (Iowa), P.E.	<i>Engineering Mechanics</i>
HERBERT A. WAHL, Ph.D. (Penn State)	<i>Botany</i>
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JOHN B. WASHKO, Ph.D. (Wisconsin)	<i>Agronomy</i>
R. HADLY WATERS, Ph.D. (Pennsylvania)	<i>Transportation</i>
ARTHUR H. WAYNICK, Sc.D. (Harvard)	<i>Electrical Engineering</i>
PALMER C. WEAVER, Ph.D. (Columbia)	<i>Education</i>
WAYNE WEBB, Ph.D. (Iowa)	<i>Physics</i>
ARTHUR M. WELLINGTON, M.A. (Ohio State)	<i>Counselor Education</i>
CLIFFORD C. WERNHAM, Ph.D. (Cornell)	<i>Plant Pathology</i>
WOLDEMAR WEYL, Dr.Ing. (Aachen)	<i>Mineral Sciences</i>
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H. SEYMOUR FOWLER, Ph.D. (Cornell)	<i>Nature and Science Education</i>
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JAMES V. FRICK, Ph.D. (Iowa)	<i>Speech</i>
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JAMES J. FRITZ, Ph.D. (California)	<i>Chemistry</i>
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LEON GORLOW, Ph.D. (Columbia)	<i>Psychology</i>
JOSEPH H. GRAHAM, Ph.D. (North Carolina State)	<i>Plant Pathology</i>
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JOHN R. HAYES, Ph.D. (Penn State)	<i>Chemistry</i>
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RODNEY E. HERSH, M.S. (Penn State)	<i>Chemical Engineering</i>
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PAUL D. HOLTZMAN, Ph.D. (Southern California)	<i>Speech</i>
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L. AILEEN HOSTINSKY, Ph.D. (Illinois)	<i>Mathematics</i>
LING-WEN HU, Ph.D. (Penn State)	<i>Engineering Mechanics</i>
LYMAN C. HUNT, JR., D.Ed. (Syracuse)	<i>Education</i>
HARRY K. HUTTON, D.Ed. (Penn State)	<i>Education</i>
HENRY W. JOHNSTONE, JR., Ph.D. (Harvard)	<i>Philosophy</i>
JENNINGS H. JONES, Ph.D. (Penn State)	<i>Chemistry</i>
JOSEPH JORDAN, Ph.D. (Hebrew University, Jerusalem)	<i>Chemistry</i>
RAM P. KANWAL, Ph.D. (Indiana)	<i>Mathematics</i>
THEODORE K. KARHAN, M.Ed. (Penn State)	<i>Music and Music Education</i>
JACOB J. KAUFMAN, Ph.D. (Columbia)	<i>Economics</i>
ROBERT W. KAUTZ, Ph.D. (Indiana)	<i>Business Statistics</i>
EARL M. KESLER, Ph.D. (Penn State)	<i>Dairy Science</i>
E. ERWIN KLAUS, Ph.D. (Penn State)	<i>Petroleum Chemistry</i>
GEORG E. KNAUSENBERGER, Dr.Ing. (Dresden)	<i>Engineering Research</i>
LEON R. KNEEBONE, Ph.D. (Penn State)	<i>Botany and Plant Pathology</i>
FRED W. KNIFFIN, D.B.A. (Indiana)	<i>Marketing</i>
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ANDREW V. KOZAK, D.Ed. (Penn State)	<i>Education</i>



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MILDRED A. LUCEY, Ph.D. (N.Y.U.)	<i>Physical Education</i>
M. FRANK MALLETT, Ph.D. (Columbia)	<i>Agricultural and Biological Chemistry</i>
VACLAV MARES, Ph.D. (Charles University, Prague)	<i>Economics</i>
CHARLES R. MARSH, M.S. (Illinois)	<i>Electrical Engineering</i>
WILLIAM H. MARTIN, Ph.D. (Harvard)	<i>Economics</i>
WILL E. MASON, Ph.D. (Princeton)	<i>Economics</i>
EDWARD L. MATIL, D.Ed. (Penn State)	<i>Art Education</i>
ROBERT H. McALEXANDER, Ph.D. (Iowa State)	<i>Farm Management</i>
FRANK J. McARDLE, Ph.D. (Purdue)	<i>Horticulture</i>
JOHN D. MCAULAY, Ed.D. (Stanford)	<i>Education</i>
ROBERT H. McCORMICK, M.S. (Penn State)	<i>Chemical Engineering</i>
EVERETT R. McLAUGHLIN, M.S. (Penn State), P.E.	<i>Engineering Research</i>
NEIL A. McNALL, Ph.D. (Cornell)	<i>American History</i>
JOSEPHINE MITCHELL, Ph.D. (Bryn Mawr)	<i>Mathematics</i>
J. HERBERT MOORE, M.S. (Penn State), P.E.	<i>Civil Engineering</i>
ARNULF I. MUAN, Ph.D. (Penn State)	<i>Metallurgy</i>
WERNER J. MUELLER, Dr.Sc.Tech. (Swiss Fed. Inst. of Tech.)	<i>Poultry Husbandry</i>
ROBERT K. MURRAY, Ph.D. (Ohio State)	<i>American History</i>
EUGENE A. MYERS, Ph.D. (Pittsburgh)	<i>Economics</i>
VERNON W. MYERS, Ph.D. (Yale)	<i>Physics</i>
WILLIAM T. NEARN, D.For. (Yale)	<i>Wood Utilization</i>
HAROLD E. NELSON, Ph.D. (Iowa)	<i>Speech</i>
MONROE NEWMAN, Ph.D. (Illinois)	<i>Economics</i>
FRANCENA L. NOLAN, Ph.D. (Penn State)	<i>Rural Sociology</i>
YOSHIHARU OKAYA, D.Sc. (Osaka)	<i>Physics</i>
GILMA M. OLSON, M.S. (Minnesota)	<i>Foods and Nutrition</i>
HOWARD B. PALMER, Ph.D. (Wisconsin)	<i>Fuel Technology</i>
LESLIE M. PAPE, Ph.D. (Chicago)	<i>Philosophy</i>
ROBERT D. PASHEK, Ph.D. (Illinois)	<i>Transportation</i>
JEROME K. PASTO, Ph.D. (Cornell)	<i>Farm Management</i>
STUART PATTON, Ph.D. (Ohio State)	<i>Dairy Science</i>
DONALD S. PEARSON, Ph.D. (St. Andrews), D.Sc., P.E.	<i>Electrical Engineering</i>
NORMAN C. PENDERED, D.Ed. (Penn State)	<i>Industrial Arts Education</i>
ROBERT P. PFEIFER, Ph.D. (Illinois)	<i>Agronomy</i>
RUTH L. PIKE, Ph.D. (Chicago)	<i>Foods and Nutrition</i>
WILLIAM S. RAY, Ph.D. (Maryland)	<i>Psychology</i>
ROBERT R. REED, JR., Ph.D. (Columbia)	<i>English Composition</i>
ROBERT D. REIFSNEIDER, M.A. (Michigan)	<i>Theatre Arts</i>
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MAX D. RICHARDS, Ph.D. (Illinois)	<i>Management</i>
NEAL RIEMER, Ph.D. (Harvard)	<i>Political Science</i>
C. MARSHALL RITTER, Ph.D. (Ohio State)	<i>Pomology</i>
H. DAVID RIX, Ph.D. (Princeton)	<i>Physics</i>
ALLAN L. RODGERS, Ph.D. (Wisconsin)	<i>Geography</i>
WILLIAM J. ROSS, Ph.D. (New Zealand)	<i>Electrical Engineering</i>
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CHARLES W. RUTSCHKY, Ph.D. (Cornell)	<i>Entomology</i>
OWEN H. SAUERLENDER, Ph.D. (Minnesota)	<i>Economics</i>
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PAUL E. SHIELDS, M.S. (Pittsburgh), E.E., P.E.	Electrical Engineering
ALBERTA E. SIEGEL, Ph.D. (Stanford)	Child Development
SIDNEY SIEGEL, Ph.D. (Stanford)	Psychology
BRUCE M. SIEGENTHALER, Ph.D. (Michigan)	Clinical Speech
RUTH C. SILVA, Ph.D. (Michigan)	Political Science
PHILIP S. SKELL, Ph.D. (Duke)	Chemistry
CYRIL B. SMITH, Ph.D. (Penn State)	Plant Nutrition
JOSEPH V. SMITH, Ph.D. (Cambridge)	Mineralogy
WARREN S. SMITH, M.A. (Iowa)	Theatre Arts
LEO H. SOMMER, Ph.D. (Penn State)	Chemistry
WILLIAM SPACKMAN, JR., Ph.D. (Harvard)	Paleobotany
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CLARENCE E. TROTTER, Ph.D. (Minnesota)	Marketing
LOREN D. TUKEY, Ph.D. (Ohio State)	Pomology
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CARL VOLZ, Ph.D. (Penn State)	Electrical Engineering
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HAROLD V. WALTON, M.S. (Penn State)	Agricultural Engineering
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FRANCIS L. WHALEY, Ph.D. (Michigan)	Psychology
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JAMES E. WRIGHT, Ph.D. (Cornell)	Genetics
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HARRY D. ZOOK, Ph.D. (Penn State)	Chemistry
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THEODORE W. GILBERT, Ph.D. (Minnesota)	<i>Chemistry</i>
KARL A. GINGERICH, Dr.rer.nat. (Freiberg)	<i>Chemistry</i>
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ROBERT W. GREEN, Ph.D. (Iowa)	<i>History</i>
PAUL GRUN, Ph.D. (Cornell)	<i>Genetics</i>
WARREN W. HASSLER, JR., Ph.D. (Johns Hopkins)	<i>History</i>
ROY B. HELFGOTT, Ph.D. (New School for Social Research)	<i>Economics</i>
LEONARD F. HERZOG, II, Ph.D. (M.I.T.)	<i>Geophysics</i>
CHARLES J. HILLSON, Ph.D. (Penn State)	<i>Botany</i>
HENRY HIZ, Ph.D. (Harvard)	<i>Mathematics</i>
HOWARD S. HOFFMAN, Ph.D. (Connecticut)	<i>Psychology</i>
NORMAN K. HOOVER, D.Ed. (Penn State)	<i>Agricultural Education</i>
ARNE W. HOVIN, Ph.D. (U.C.L.A.)	<i>Genetics</i>
GEORGE R. HUDSON, Ed.D. (Columbia)	<i>Education</i>
DOUGLAS N. JACKSON, JR., Ph.D. (Purdue)	<i>Psychology</i>
WALTER JAUNZEMIS, Ph.D. (Illinois Tech.)	<i>Engineering Mechanics</i>
BERNARD R. JERMAN, Ph.D. (Ohio State)	<i>English Literature</i>
DONALD G. JOHNSON, Ph.D. (Purdue)	<i>Mathematics</i>
RICHARD N. JORGENSEN, D.For. (Yale)	<i>Wood Technology</i>
PHILIP G. KEENEY, Ph.D. (Penn State)	<i>Dairy Science</i>



## ASSISTANT PROFESSORS

HELEN L. KINSLOE, M.S. (Penn State)	Bacteriology
JOSEPH E. KIST, Ph.D. (Purdue)	Mathematics
PHILIP A. KLEIN, Ph.D. (California)	Economics
ANTON J. KOVAR, Ph.D. (Rome)	Botany
HERMAN C. KRANZER, Ed.D. (U.C.L.A.)	Education
DONALD T. LAIRD, Ph.D. (Penn State)	Engineering Research
LAURENCE H. LATTMAN, Ph.D. (Cincinnati)	Geomorphology
JOSEPH T. LAW, M.A. (Wisconsin)	Political Science
HUON LI, Ph.D. (California)	Aeronautical Engineering
MARY LISTER, Ph.D. (London)	Mathematics
WALLIS A. LLOYD, Ph.D. (Minnesota)	Chemical Engineering
JOHN R. LOTZ, Ph.D. (Penn State)	Chemistry
HAROLD L. LOVELL, Ph.D. (Penn State)	Mineral Preparation
SIDNEY F. MACK, Ph.D. (California)	Mathematics
LAWRENCE F. MARRIOTT, Ph.D. (Wisconsin)	Soil Technology
HAROLD G. MARSHALL, Ph.D. (Minnesota)	Agronomy
MARGARET B. MATSON, Ph.D. (Penn State)	Sociology
T. KING McCUBBIN, JR., Ph.D. (Johns Hopkins)	Physics
MONTY J. MONTJAR, Ph.D. (Carnegie Tech.)	Chemistry
J. MITCHELL MORSE, Ph.D. (Penn State)	English Composition
GERALD M. MOSER, D.U.P. (Paris)	Romance Languages
JOHN B. NESBITT, Sc.D. (M.I.T.)	Civil Engineering
ROBERT S. NOVOSAD, Ph.D. (Chicago)	Mathematics
WAYNE T. O'DELL, Ph.D. (Penn State)	Dairy Science
BENNIE F. OLIVER, Ph.D. (Penn State)	Metallurgy
EUGENE K. OXHANDLER, D.Ed. (Columbia)	Audio-Visual Education
WILLIAM J. PAGE, Ed.D. (Temple)	Education
GEORGE PAPPAS, D.Ed. (Penn State)	Art and Art Education
WILLIAM J. PERVIN, Ph.D. (Pittsburgh)	Mathematics
REED T. PHALAN, J.D. (Michigan Law)	Business Law
ELLEN V. PIERS, Ph.D. (George Peabody)	Psychology
JOHN E. PIXTON, JR., Ph.D. (Chicago)	History
ROBERT M. POCKRASS, Ph.D. (Stanford)	Journalism
THEODORE S. POLANSKY, Ph.D. (Penn State)	Fuel Technology
BERNARD L. POLLACK, Ph.D. (Penn State)	Plant Breeding
WILLIAM W. PRATT, Ph.D. (Iowa State)	Physics
WILLIAM F. PROKASY, Ph.D. (Wisconsin)	Psychology
JAN S. PRYBYLA, Ph.D. (Cork)	Economics
MARGARET C. RAABE, M.S. (Penn State)	Clinical Speech and Speech Education
JOHN L. RAGLAND, Ph.D. (North Carolina State)	Soil Technology
GEORGE N. RANEY, Ph.D. (Columbia)	Mathematics
HERMAN G. RICHEY, JR., Ph.D. (Harvard)	Chemistry
GUY E. RINDONE, Ph.D. (Penn State)	Ceramic Technology
RADHA R. ROY, Ph.D. (London)	Physics
MARTIN W. SCHEIN, Sc.D. (Johns Hopkins)	Animal Behavior
RICHARD D. SCHEIN, Ph.D. (California)	Plant Pathology
JAMES A. SCHINNELLER, M.F.A. (Iowa)	Art Education
ROBERT F. SCHMALZ, A.M. (Harvard)	Geology
ERWIN R. SCHMERLING, Ph.D. (Cambridge)	Electrical Engineering
C. DAVID SCHMULBACH, Ph.D. (Illinois)	Chemistry
MAURICE SHAMMA, Ph.D. (Wisconsin)	Chemistry
JAMES W. SHIGLEY, Ph.D. (Penn State)	Agricultural and Biological Chemistry

## ASSISTANT PROFESSORS

THOMAS SMYTH, Jr., Ph.D. (Johns Hopkins)	<i>Entomology</i>
FRANCIS J. SORAUF, Ph.D. (Wisconsin)	<i>Political Science</i>
CLARK C. SPENCE, Ph.D. (Minnesota)	<i>History</i>
WILLIAM J. STAMBAUGH, Ph.D. (Yale)	<i>Forest Pathology</i>
WILLIAM A. STEELE, Ph.D. (Washington)	<i>Chemistry</i>
ROBERT E. STOVER, Ph.D. (Penn State)	<i>Psychology</i>
H. TRACY STURCKEN, Ph.D. (North Carolina)	<i>Romance Languages</i>
JAMES TAMMEN, Ph.D. (California)	<i>Plant Pathology</i>
GEORGE A. THEODORSON, Ph.D. (Cornell)	<i>Sociology</i>
CHARLES P. THORNTON, Ph.D. (Yale)	<i>Petrography</i>
HUGH B. URBAN, Ph.D. (Penn State)	<i>Psychology</i>
FRANCIS J. VASTOLA, Ph.D. (Penn State)	<i>Fuel Technology</i>
DARRELL E. WALKER, Ph.D. (California)	<i>Plant Breeding</i>
M. JEROME WEISS, Ed.D. (Columbia)	<i>Education</i>
LAWRENCE L. WERBOFF, Ph.D. (Stanford)	<i>Economics</i>
SAMUEL F. WILL, JR., Ph.D. (Yale)	<i>Classical Languages</i>
EUGENE G. WILLIAMS, Ph.D. (Penn State)	<i>Geology</i>
DONALD J. WILLOWER, Ed.D. (Buffalo)	<i>Education</i>
ROLF G. WINTER, D.Sc. (Carnegie Tech.)	<i>Physics</i>
ARTHUR E. WOODWARD, Ph.D. (Brooklyn Polytech.)	<i>Physics</i>
RICHARD N. WORK, Ph.D. (Cornell)	<i>Physics</i>
PETER J. WYLLIE, Ph.D. (St. Andrews)	<i>Geochemistry</i>

## INSTRUCTORS

HARRISON T. MESEROLE, Ph.D. (Maryland)	<i>English</i>
BRUCE R. SHOBAKEN, M.F.A. (Minnesota)	<i>Art</i>
STANLEY WEINTRAUB, Ph.D. (Penn State)	<i>English Literature</i>

## OTHER MEMBERS OF THE GRADUATE FACULTY

JOSEPH ALESSANDRO, D.Ed. (Penn State)	<i>Education</i>
LELAND L. BEIK, Ph.D. (Columbia)	<i>Marketing</i>
ALFRED J. ENGEL, B.Che.E. (Cornell)	<i>Chemical Engineering</i>
LESLIE P. GREENHILL, B.Com. (Melbourne)	<i>Academic Research and Services</i>
KENNETH W. HYLBERT, D.Ed. (Penn State)	<i>Rehabilitation Counseling</i>
OSCAR A. KIMMEL, M.S. (Penn State)	<i>Farm Mechanics</i>
J. CAMPBELL LESTER, M.S. (Penn State), P.E.	<i>Mechanical Engineering</i>
SEYMOUR LEVENTMAN, Ph.D. (Minnesota)	<i>Sociology</i>
GUY W. MCKEE, Ph.D. (Penn State)	<i>Agronomy</i>
CARL R. MOSS, M.B.A. (Harvard)	<i>Industrial Engineering</i>
AMOS E. NEYHART, M.S. (Penn State)	<i>Institute of Public Safety</i>
STANLEY H. ROSEN, Ph.D. (Chicago)	<i>Philosophy</i>
DELLA M. ROY, Ph.D. (Penn State)	<i>Geochemistry (part-time)</i>
HARALD SCHRAER, Ph.D. (Cornell)	<i>Biophysics</i>
JAMES L. STARLING, Ph.D. (Penn State)	<i>Agronomy</i>
WALTER F. WESTERFELD, M.S. (Penn State)	<i>Botany</i>
MARTIN L. ZEIGLER, Ph.D. (Penn State)	<i>Student Affairs Research</i>





# GENERAL INFORMATION

GRADUATE WORK at The Pennsylvania State University was first offered in 1862 when two graduate students were in residence. It was given more formal recognition in 1864 by the establishment of a "course for Graduates" designed for students who, after receiving the degree of Bachelor of Scientific Agriculture, wished to do advanced work leading to the degree of Master of Scientific Agriculture. For some time there were few graduate students, and graduate instruction was relatively unorganized. Later a committee of the University Senate was given the responsibility of establishing standards and regulations governing graduate work and the granting of advanced degrees. The Graduate School was organized in 1922. Until this time only masters' degrees and certain technical degrees had been conferred. In 1924, the Board of Trustees authorized the granting of the degree of Doctor of Philosophy. Still later other degrees were approved.

The faculty of the Graduate School consists of the President and certain other general administrative officers of the University, the Deans, the Librarian, the heads of departments, and those members of the instructional staff who have been authorized by the proper agencies of the Graduate School to offer graduate courses and supervise research leading to theses. It controls all academic matters pertaining to the Graduate School, subject to review by the University Senate.

The Graduate Faculty has approximately 660 members. Graduate student enrollment was about 2200 per semester in 1958-59 and about 3050 during the summer of 1959. The number of advanced degrees conferred in 1958-59 was 744, of which 129 were doctorates.

## PROCEDURES AND REGULATIONS

A student is expected to assume full responsibility for knowing the regulations and pertinent procedures of the Graduate School as set forth in this publication, the *Manual for Graduate Students*, and the *Thesis Information Bulletin*, and for meeting the standards and requirements expressed by these regulations. The *Manual*, which is available to a student after he has been admitted, sets forth in more detail the procedures governing registration, changes in program, and graduation, and gives other information about the Graduate School which is useful to graduate students. Every student should secure a copy of this manual from the Dean's office as soon after admission as possible.

**ADMISSION**—An applicant for admission to the Graduate School should understand that graduate work is not an extension of undergraduate work. It operates at a definitely higher level, demands scholarship of a high order, and emphasizes research and creativity. It involves a minimum of formal requirements and regulations, and a maximum of student initiative and responsibility.

A student does not become a graduate student merely by enrolling for advanced courses after having received a baccalaureate degree. Formal admission to the Graduate School is required. Credits earned before admission cannot be applied to meet degree requirements at a later date even though admission may have been granted in the meantime.

Admission is granted by the Dean of the Graduate School after approval of the application by the department in which the student plans to do his major work. Blanks to be used in making formal application for admission can be obtained from the Graduate School office. In general, a student may begin his graduate work in

## ADMISSION

fall, spring, or summer. Prospective students may write directly to the head of any department concerning graduate work in that specific field.

Students from other countries are encouraged to write to the Director of International Student Affairs for information concerning finances, housing, and other nonacademic matters.

An applicant for admission should provide complete credentials, in duplicate, sent directly from other institutions to the Dean of the Graduate School at least six weeks prior to the opening of the session in which he plans to begin his graduate program. If the applicant has attended more than one institution, two official transcripts of the work covered at each institution are required. This applies to the complete academic record, both undergraduate and graduate.

For unqualified admission to the Graduate School an applicant must have received a baccalaureate degree from an accredited institution, earned under residence and credit conditions substantially equivalent to those required by The Pennsylvania State University. He must have maintained during his junior and senior years a minimum grade point average equivalent to 2.5 on The Pennsylvania State University grading scale (approximately half B and half C). Finally, he must ordinarily have completed in a satisfactory manner a certain minimum of course work in designated areas, the specific courses and amount of required work depending upon the field of advanced study which the student proposes to enter. The minimum grade point average of 2.5 during the last two undergraduate years is a general requirement of the Graduate School. Individual departments may require a higher average for admission in their fields.

Some divisions are participating in an experiment on conditional admission for applicants whose undergraduate grade point average is below 2.5 but whose qualifications in other respects seem to suggest probable success in the Graduate School. Such an applicant must realize that the initiative rests entirely with him in communicating with the department of his chosen major and that, if admitted conditionally, he does graduate work at his own risk. There is no assurance that he will subsequently be granted unqualified admission or that the credits earned will automatically be applied toward degree requirements. Applicants for admission on a conditional basis must have all of the essential materials for consideration for admission to that status on file with the Dean of the Graduate School at least six weeks before they wish to register in the Graduate School.

Provisional admission may be granted to an applicant whose complete credentials are not available at the time of registration, but this admission will be subject to cancellation if the credentials, on their arrival, do not meet the requirements for admission to the Graduate School. Also, while the applicant is holding provisional admission, certification of any scheduled credits will be withheld until receipt of his official credentials makes possible his unqualified admission to the Graduate School. If the provisional admission should, for any reason, be canceled, the student is thereby automatically dropped from the Graduate School and as a consequence will be required to cease attending any 500 level courses for which he may have registered. He may continue to attend 400 level courses provided he applies for and is accepted for registration as a special student.

A student with a slight deficiency in undergraduate preparation may be admitted and allowed to take a limited number of undergraduate courses to make up the deficiency while proceeding with his graduate program. Courses taken for this purpose do not, of course, apply toward the requirements for an advanced degree.

Formal readmission is not required year by year nor after one or more semesters of absence from the campus unless the student has completed more than 12



## CLASSIFICATION

credits of work at another institution in the meantime. In this case readmission is required, and evidence of good standing at the institution involved is essential. A student who has earned a master's degree at The Pennsylvania State University should not register for further degree work until his academic record and personal qualifications have been reviewed critically by the department of his major interest and a candidacy evaluation has been completed.

The President of the University, on recommendation of the Dean of the Graduate School, will welcome doctors of philosophy of The Pennsylvania State University, as well as those of other accredited colleges and universities, as guests of the University, with the privilege of attending seminars and courses and of carrying on research. There will be no charge except for laboratory expenses. Arrangements should be made in advance with the Dean of the Graduate School.

A senior student of The Pennsylvania State University lacking not more than 4 credits for graduation may be admitted to the Graduate School. This limit may be increased to 8 credits in the case of a student with an average of at least B (a grade point average of 3). Any senior with a 3.5 grade point average may be admitted to 500 level courses with the consent of the instructor; other undergraduate students may be admitted to such courses with the consent of the instructor and the Dean of the Graduate School. Those not admitted to the Graduate School cannot use these credits toward an advanced degree.

**CLASSIFICATION**—At the time of admission to the University, students are classified as graduate, special, or undergraduate students, depending upon their objectives and qualifications.

A graduate student is classified either as a regular or as a general graduate student depending upon whether or not he is working toward an advanced degree at The Pennsylvania State University. Regardless of classification, all students, upon admission to the Graduate School, must register through the Graduate Dean's office for all work taken, whether or not that work is to be credited toward the requirements for a degree.

A special student is not a graduate student, inasmuch as he has not been admitted to the Graduate School, and may not register for graduate courses or research (500 and 600 series) without permission of the Dean of the Graduate School. A special student may register for 400 level courses, provided he has attained at least junior standing in college. Except for most unusual reasons, a special student who is later admitted to the Graduate School may not then count toward degree requirements any credit he has earned while in the special student status.

A person holding a baccalaureate degree and working only for permanent certification as a teacher or administrator in the public schools is advised to apply for admission as a general graduate student.

Changes in classification are arranged through the Graduate School office and, in the case of a change from general to regular status, the approval of the head of the major department in which the student proposes to work is required.

Regular graduate students include those persons who plan to become candidates for degrees at The Pennsylvania State University and who have been formally admitted for advanced study in a particular field. The program of study is developed under the guidance of a department head or his representative. A graduate student who plans to become a candidate for an advanced degree should enroll as a regular graduate student.

It should be emphasized that a student is not a "regular graduate student" unless he has been officially admitted to that status. Regular attendance in the



## REGISTRATION

Graduate School, or personal plans for future degree candidacy, do not in themselves carry with them the status or privileges of a regular graduate student.

A regular graduate student who has passed a candidacy evaluation is classified as a doctoral candidate.

An applicant who meets all requirements for admission to the Graduate School, but who does not wish to work for an advanced degree at this institution, may arrange for a program of work as a general graduate student. This classification includes those who plan to transfer credits to another institution and those who plan a special program of study not leading to an advanced degree.

The adviser for a general graduate student is appointed by the Dean of the Graduate School. The student's status and standing will be reviewed by the Dean at each registration. He may not remain a general graduate student longer than one semester (or summer sessions totaling 12 weeks) except with the permission of the Dean, and for definite and good reasons.

When a general graduate student wishes to become a regular graduate student—i.e., to work for an advanced degree at this institution—he should make application to the Dean of the Graduate School for change of status. His undergraduate record will then be re-evaluated to determine whether or not he is prepared to undertake graduate work for a degree in the major field of his choice. He should understand that he may thereafter apply toward degree requirements only those credits earned as a general graduate student which fit definitely and logically into an integrated degree program. There is no upper limit to the number of credits that may be so applied; neither is there a guarantee that any such credits may be applicable.

REGISTRATION—The responsibility for being properly registered rests with the student. At least until he has met the minimum requirements for his degree, a student must register for each semester and each summer session in which he proposes to do either course work or research, or other work on his thesis, either on or off campus. In the case of research the number of credits shall be determined by the amount of time required for the investigation, one credit representing one week of full-time graduate work.

When a candidate has met minimum requirements for a degree, further registration shall be required only for course work, project work, and research work requiring the use of University facilities and supplies (including laboratory, library, and others). This means, for instance, that if a student has completed three years of work (90 credits) of a doctoral program, has completed his research on campus, and has permission from the Dean to complete his work *in absentia*, he need not register for credits. Similarly, a student who has earned 90 credits, but who still has much research to do which does *not* involve using University facilities, and who receives permission to complete his work at, for example, the Library of Congress, need not register. On the other hand, a student who uses University facilities for all his research must be registered for credit at all times, regardless of the number of credits that may accrue before he completes his work.

A candidate need not register for the semester or session in which the degree is to be conferred if his work has been completed except for minor revisions of the thesis and the passing of the final oral examination.

For each registration the student, in consultation with his adviser, prepares a schedule of courses and research designed to fit his individual needs, which is then submitted to the Dean of the Graduate School for his approval. The registration process is then completed in the manner specified for all students at the University.

Under certain conditions credit may be earned by work done off the campus. A student contemplating such work should inquire of the Dean of the Graduate

## ACADEMIC LOAD

School about the procedures and conditions. Such work must be scheduled *in advance* in the regular manner.

A resident student is required to register in person, not by proxy. A nonresident student is expected to assume responsibility for initiating the registration process, but the details can be handled by mail. A student must register for courses audited as well as for those taken for credit.

**TIME OF REGISTRATION**—The regular registration days are indicated in the University Calendar. Graduate students follow the same registration schedule as undergraduates do.

A student is expected to complete his registration during the officially designated period and to attend the first meeting of all classes in which he is enrolling. If this is impossible because of some emergency or unusual circumstance beyond his control, the student may be granted permission by his instructors to miss a few class meetings, it being understood that work missed will be made up subsequently. Under these conditions the Dean of the Graduate School may grant the student permission to register late. In general, a student who receives permission to register late will be required to reduce his program in proportion to the amount of time which he has been absent.

Regardless of when he may begin attending classes, a student who fails to complete the process of registration within the officially designated registration period will be liable for the late registration fee.

**LOADS, ACADEMIC AND EMPLOYMENT**—Many students depend upon part-time employment to help meet their expenses. A student who is thus employed, however, must recognize the time demands of his work schedule in planning his academic program.

The University takes the position that the facilities of the Graduate School should be made available only to students who can profit from their Graduate School experience to a maximum extent. Therefore the Graduate School reserves the right to deny admission or registration to part-time students who (a) propose schedules of few credits which seem to reflect little real interest in graduate work or would not seem to require serious effort, or (b) wish to carry overloads of such proportion as to handicap them seriously in achieving maximum quality in their graduate work.

“Doing graduate work” means more than doing what is required in courses or in research. It means living in a scholarly atmosphere and seriously engaging in scholarly pursuits. It means profiting from hearing visiting scholars and artists and from engaging in discussions, both formal and informal, with faculty members and fellow students. It should mean leisure time for reflection and for exploring fields related to, although not directly a part of, one’s specialty. Overloads make it difficult and often impossible to do graduate work so conceived. Hence the following “protective” schedule of permitted loads for students who are employed has been adopted:

EMPLOYMENT		CREDITS ALLOWED	
<i>Hours per Week</i>	<i>Percentage of Full Time</i>	<i>Credits</i>	<i>Percentage of Full Load</i>
0	0	15	100
10	25	11-13	80
20	50	8-10	60
30	75	6- 8	50
40	100	6	40



## GRADING SYSTEM

This means, for example, that anyone working 20 hours per week (about half-time) whether as a half-time graduate assistant, as an employee on campus, or as an employee off-campus, will be limited in the amount of graduate work for which he may register to about three-fifths (or 60 per cent) of a normal full time load (i.e., to 8-10 credits). The term employment is used in a very general sense and includes working for indirect compensation such as housekeeping, working in the family business, maintaining a large vegetable garden, etc. Hence, all students who are thus employed will be expected to adjust their academic loads accordingly. Exceptions, in the case of students who have demonstrated unusual ability, must be arranged with the Dean of the Graduate School at the time of registration. (See also Auditing and Visiting Classes.)

A student holding a fellowship, graduate assistantship, or scholarship is not permitted to accept employment of any kind for service beyond that specified by his appointment.

**AUDITING AND VISITING CLASSES**—A regularly registered graduate student who wishes to take a course without credit may be allowed to do so upon securing the permission of the instructor in the course and the approval of the Dean of the Graduate School. Such a student, known as an auditor, may, if he wishes, participate in class discussion, do practicum work, submit written work, and take examinations. He must register for the course in the same manner as if he were taking the course for credit and must pay fees on the same basis. He receives no grade in the course and cannot subsequently claim any sort of credit for work done in the course. Ordinarily a student is required to count the courses audited as a part of his normal credit load.

A regularly registered student of the Graduate School may at any time during a regular semester visit, with the permission of the instructor, a class for which he is not registered. During summer sessions he must also obtain the permission of the Dean of Summer Sessions. Under this provision the student may not claim the usual privileges of class membership, such as participating in class discussion, doing practicum work, submitting written work, and taking examinations. This privilege is officially designated as "visiting classes without registration," and no record of it appears on the student's transcript.

**STATUS UNDER SELECTIVE SERVICE**—As soon as an applicant has been admitted to the Graduate School, his local board will be informed *provided* the applicant requests it and has given the necessary information. As soon as he receives notification of admission, the applicant should check with the Associate Registrar to see that everything is in order.

A student is certified to be a full-time student insofar as Selective Service is concerned if he schedules at least 12 credits in a semester, if he holds an appointment as a quarter-time or half-time graduate assistant, or if he is serving an internship under approved conditions.

Whenever a student changes his status so as no longer to be considered a full-time student, fails to make satisfactory progress, or makes a drastic change in his declared goal, his local board will be notified.

**GRADING SYSTEM**—A grade is given solely on the basis of the instructor's judgment as to the student's scholarly attainment.

For graduate courses (500 series) and for research or thesis (600 or 610) one of three grades may be given:

H for Honors, indicating definitely superior attainment.

P for Pass, indicating acceptable but not superior attainment.



## TUITION

F for Fail, indicating failure to attain the acceptable minimum standard of work or to spend an adequate amount of time doing the work scheduled.

In addition to the quality grades listed above, two symbols, "deferred" and R, may appear on a student's transcript. If work is incomplete at the end of a session for a reason beyond the student's control, or if very little work remains to be done, the instructor may report "deferred" in place of a grade, which will appear temporarily on the student's record.

In the case of thesis work, either in progress or completed, the instructor may report the symbol R in place of a grade. This symbol indicates that the student has devoted an adequate amount of time to the work scheduled but gives no indication of its quality. An R remains on the student's transcript permanently. If, after having submitted a series of R symbols, the instructor reports a grade of H, P, or F for a specific session, this grade is considered to apply to the preceding series of registrations and to denote the quality of that entire series.

For 400 series courses one of five grades may be given:

<i>Grade</i>	<i>Percentage Equivalent</i>	<i>Grade Point Equivalent</i>
A	90-100	4
B	80- 89	3
C	70- 79	2
D	60- 69	1
F (Failure)	0- 59	0

Grades below B do not carry graduate credit and are considered failures in the program of a graduate student.

**GRADUATION**—It is the responsibility of the student to inform the Graduate Recorder of his intention to graduate, and to pay thesis fees at the beginning of the semester or session when he expects to receive an advanced degree. Deadlines are given in the calendar on pages 3 to 6.

Degrees are granted at the end of each semester and at the end of the Mid-Session.

All degrees conferred are tentative until final grade reports have been received even though the student's name may have appeared in the commencement program.

Attendance at commencement exercises is an obligation on the part of those receiving advanced degrees. A request to receive the degree *in absentia* may be presented to the Dean of the Graduate School, but only under unusual circumstances will it be granted. See the *Manual for Graduate Students* for a detailed statement of procedure.

## TUITION AND LIVING ACCOMMODATIONS

### *Total Tuition Each Semester, 12 or More Credits:*

Pennsylvanian . . . . .	\$240.00
Non-Pennsylvanian, on-campus studies . . . . .	480.00
Non-Pennsylvanian, research in absentia (610) . . . . .	240.00

### *Tuition Each Semester, Fewer than 12 Credits:*

Pennsylvanian, per credit . . . . .	20.00
Non-Pennsylvanian, on-campus studies, per credit . . . . .	40.00
Non-Pennsylvanian, research in absentia (610), per credit . . . . .	20.00

### *Vocational Education Courses: Total charge for these courses, indicated by "v" following the course number . . . . .*

	20.00
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## TUITION

### *Special Charges, Payable as Occasion Demands and Applicable to All Students:*

Admission to the Graduate School . . . . .	10.00
Privilege of late registration or late payment . . . . .	10.00
Change of schedule, each change . . . . .	2.00
Microfilming of doctoral thesis and publication of abstract . . . . .	35.00
Minimum fee for binding of thesis, per copy . . . . .	3.00
Official transcript of record (with seal), each copy . . . . .	1.00

The University reserves the right to revise tuition and charges without further notice.

Tuition is the same for audit courses as for those scheduled for credit.

Summer sessions students who register for graduate courses pay the regular tuition for the summer sessions.

Any student who does not fulfill payment obligations promptly may be charged \$1 for each day of delinquency up to and including five days, or a maximum of \$10 if the delinquency exceeds five days. A student whose account is delinquent for more than 10 days is subject to suspension from the University.

Whenever it shall appear from any of the information presented as part of the application for admission that the applicant is not domiciled in Pennsylvania, the Dean of Admissions, when admission is granted to that applicant, assumes that the one admitted is a non-Pennsylvanian and includes that admission as a part of the established out-of-State quota. If the student who is thus admitted believes that his circumstances do not justify his classification as a non-Pennsylvanian, he may petition the Dean of Admissions for reclassification.

When a petition for reclassification is made, the petitioner is required to present proof of a bona fide continuous domicile of the one admitted (or of his parents, if he is a minor) within the Commonwealth for a period of at least 12 months immediately preceding the date of such petition for reclassification; and, in addition, such other evidence as is pertinent to a complete review of his classification.

Any student who changes his domicile while attending the University is subject to reclassification effective at the beginning of the first semester following the twelfth month after such change has taken place.

**REFUNDS OF CHARGES FOR TUITION**—Charges for tuition are refundable in part upon withdrawal from the University provided the student obtains the Official Withdrawal Form at the Office of the Dean and presents it to the office of the Fee Assessor not later than one calendar month after the effective date of withdrawal from classes. Refunds for a semester are made according to the following schedule.

90 per cent refund upon withdrawal before the end of the first week of classes and a decrease of 10 per cent for each consecutive calendar week thereafter up to and including the 9th consecutive week. No amount will be refunded upon withdrawal after the 9th consecutive calendar week of the semester.

**LIVING ACCOMMODATIONS**—Graduate Hall, located on central campus, provides for about 80 single students including both men and women. For detailed information write to Room Assignment Office, 1-A Irvin Hall. Other living accommodations are available including rooms in private homes and lodging houses. The cost varies considerably depending upon the type of accommodation. A list of known vacancies is maintained by the offices of the Dean of Men and the Dean of Women and by the Graduate Student Association. The prospective student should write to the appropriate office well in advance of the beginning of classes



because it may be very difficult to find a convenient location at the last minute. Boarding houses, restaurants, and the Hetzel Union Cafeteria on campus, are available for meals.

A married student may find accommodations in apartments, trailers, and rooms in private homes. Personal contact is essential, but assistance may be gained through the office of the Dean of Men or an advertisement in the local newspaper.

A new housing development to be completed in the fall of 1960 will provide 216 unfurnished one- and two-bedroom units for married graduate students having no school-age children. For details write to Department of Housing, 1-A Irvin Hall.

## STUDENT AIDS AND SERVICES

In every case in which a graduate assistantship, scholarship, or fellowship for the next academic year is offered to an actual or prospective graduate student, the student, if he indicates his acceptance before April 15, will have complete freedom through April 15 to submit in writing a resignation of his appointment in order to accept another graduate assistantship, scholarship, or fellowship. However, an acceptance given or left in force after April 15 commits him not to accept another appointment without first obtaining formal release for the purpose.

**ASSISTANTSHIPS**—Approximately 800 graduate assistantships are awarded annually. Most of these are half-time, but a limited number of quarter-time and three-quarter-time assistantships are available in some departments.

The assistantships vary in stipend, service required, and the number of credits for which a student may register, as follows:

**QUARTER-TIME**, requiring about 10 hours of service per week.

For the academic year: stipend \$603-\$1008; 11-13 credits per semester.

For the fiscal year: stipend \$804-\$1344; 11-13 credits per semester, 8-9 credits in summer sessions.

**HALF-TIME**, requiring about 20 hours of service per week.

For the academic year: stipend \$1206-\$2016; 8-10 credits per semester.

For the fiscal year: stipend \$1608-\$2688; 8-10 credits per semester, 6-8 credits in summer sessions.

**THREE-QUARTER-TIME**, requiring about 30 hours of service per week.

For the academic year: stipend \$1809-\$3024; 6-8 credits per semester.

For the fiscal year: stipend \$2412-\$4032; 6-8 credits per semester, 4-6 credits in summer sessions.

In addition to the stipend listed above each graduate assistant receives a grant-in-aid which covers tuition but not the special charges such as admission, late registration, and change of schedule.

A prospective student should write directly to the head of his major department for information and application forms. Appointments are made upon the recommendation of the department head, subject to admission to the Graduate School. Clear evidence of superior ability and promise is required. Reappointment to an assistantship requires a continuing demonstration of good scholarship.

An appointee may serve as an assistant in classroom or laboratory instruction, or in research or other work. Vacation for a graduate assistant consists of the regular student vacations available to all graduate students. Privileges for a



## FELLOWSHIPS

graduate assistant appointed for the academic year do not extend into any of the summer sessions.

A graduate assistant may not accept additional employment, either at the University or elsewhere, during the period for which service to the University is required under the appointment.

A quarter-time or a half-time graduate assistant is considered to be a full-time student and a three-quarter-time graduate assistant is considered to be a half-time student insofar as benefits under Public Law 550 are concerned.

A student holding a quarter-time or a half-time assistantship is considered to be following a full-time course of instruction under Selective Service regulations and is so certified to his local draft board. A student holding a three-quarter-time assistantship is not considered to be following a full-time course of instruction.

**COUNSELORSHIPS**—A number of appointments are available to male students to serve as resident counselors in the undergraduate residence halls for men. A counselor's responsibility is to work for the social, academic, and emotional adjustment of the undergraduate residents. Specialized training in personnel work is desirable, though not essential.

These appointments are for the academic year and carry with them remission of charges for room and board, but not exemption from tuition, except that all counselors pay the same tuition as would residents of Pennsylvania. A counselor may not hold a fellowship or a graduate assistantship during the term of his appointment as counselor.

Applications and requests for information should be addressed to the Dean of Men.

**FELLOWSHIPS**—More than 100 fellowships are awarded annually. Recipients must be superior students and are frequently required to have completed a certain minimum of graduate work before being eligible for an award. Fellows carry a full-time graduate program, receive a stipend which varies with the award, and receive a grant-in-aid paid by the donor of the fellowship to provide for all tuition charges. They may not accept employment during the term of their appointment, nor are they required to render any service to the University. In some cases a fellow will be expected to limit his research to a broad field specified by the donor. Fellows are required to pay specific charges such as admission, late registration, change of schedule, and thesis binding and microfilming fees.

**GRADUATE SCHOOL FELLOWSHIPS**—Eleven fellowships, each paying a stipend of \$2000 and providing a grant-in-aid to cover all tuition charges for the academic year, are given by the University and are designated as Graduate School Fellowships. They are available to outstanding advanced graduate students in any field, although preference is given to applicants majoring in the humanities and social sciences. An applicant must have completed at least one full year of graduate study prior to beginning the fellowship tenure and be a candidate for the doctoral degree.

Applications should be addressed to the Dean of the Graduate School and must be received by March 1 in order to be considered for the following academic year.

**FELLOWSHIPS FROM FOUNDATIONS AND INDUSTRIES**—At least 90 such fellowships, with various stipends, are awarded through the individual departments. Information and application forms may be secured from the head of

## FELLOWSHIPS

the major department concerned. The fellowships which are awarded will vary somewhat from year to year, but the following are typical of those which were available for 1959-60:

**ALLEGHENY LUDLUM FELLOWSHIP**—Open to graduate students in metallurgy for studies in steelmaking; stipend \$2880.

**ALLIED CHEMICAL AND DYE CORPORATION FELLOWSHIP IN CHEMICAL ENGINEERING**—Available to a graduate student in chemical engineering; stipend \$2000.

**ALLIED CHEMICAL AND DYE CORPORATION FELLOWSHIP (PLASTICS AND COLD CHEMICALS DIVISION)**—Available to a graduate student in fuel technology; stipend \$1500.

**AMERICAN CYANAMID FELLOWSHIP IN CHEMISTRY AND CHEMICAL ENGINEERING**—Open to a graduate student for the final year of study leading to the Ph.D. degree. Awarded in alternate years to a chemist and to a chemical engineer; stipend \$1800.

**AMERICAN IRON AND STEEL INSTITUTE (2)**—Open to graduate students in metallurgy; stipend \$2400-\$3600.

**AMERICAN PETROLEUM INSTITUTE FELLOWSHIPS (2)**—Open to graduate students in chemistry and physics for research concerning the synthesis and properties of high molecular weight hydrocarbons; stipend \$2400-\$3600.

**AMERICAN PETROLEUM INSTITUTE FELLOWSHIPS (4)**—Open to predoctoral and postdoctoral students in geochemistry, ceramic technology, or allied fields, for fundamental research concerning the synthesis and properties of clays and related inorganic phases; stipend \$2136.

**ARMSTRONG CORK COMPANY SUMMER RESEARCH FELLOWSHIPS IN CHEMISTRY**—Open to graduate teaching assistants in chemistry for support of study during the summer terms; stipend \$534.

**BASIC, INC., FELLOWSHIP**—Open to graduate students in ceramic technology; stipend \$2400.

**CARBORUNDUM CORPORATION FELLOWSHIP**—Available to a graduate student in mineral preparation; stipend \$2040.

**CONTINENTAL OIL COMPANY FELLOWSHIP**—Available to graduate students in petroleum and natural gas engineering for studies in petroleum engineering; stipend \$2000.

**CO-OPERATIVE PROGRAM FELLOWSHIP**—Open to graduate students in metallurgy; stipend \$2280.

**CORNING GLASS WORKS FOUNDATION FELLOWSHIP**—In support of graduate work on glass or any of its components; stipend \$2300.

**DEVEREUX FELLOWSHIP**—Open to selected graduate students in clinical and school psychology; stipend \$840 to \$1920 throughout Ph.D. program.

**DOW CORNING FELLOWSHIPS (7)**—Open to graduate students in chemistry for fundamental studies in organosilicon compounds; stipend \$2040.

**EASTMAN KODAK FELLOWSHIP IN CHEMISTRY (2)**—Open to advanced graduate students in chemistry for study leading to the Ph.D. degree; stipend \$2500.

**ESSO RESEARCH AND ENGINEERING POSTGRADUATE FELLOWSHIP IN CHEMISTRY AND CHEMICAL ENGINEERING**—Open to advanced graduate students for one year of study leading to the Ph.D. degree; stipend \$1800.

**FOOTE MINERAL COMPANY FELLOWSHIP**—Available to graduate students in ceramic technology; stipend \$2000.



## FELLOWSHIPS

GENERAL ELECTRIC FELLOWSHIP—Open to graduate students in metallurgy; stipend \$2880.

GENERAL FOODS FUND FELLOWSHIP (2) —For graduate work with a major in home economics; stipend \$2500.

B. F. GOODRICH COMPANY FELLOWSHIP—For graduate work in physics; stipend \$1800.

GULF OIL COMPANY FELLOWSHIP IN PETROLEUM AND NATURAL GAS ENGINEERING—For graduate work in petroleum production; stipend \$2000.

HAMILTON STANDARD FELLOWSHIP—Open to graduates of this University in aeronautical engineering, electrical engineering, mechanical engineering, and engineering mechanics; stipend \$1800.

INTERNATIONAL BUSINESS MACHINE COMPANY FELLOWSHIP—For graduate work in electrical engineering; stipend \$2500.

JONES AND LAUGHLIN FELLOWSHIP—Open to graduate students in ceramic technology for studies in refractories; stipend \$2000.

KAISER ALUMINUM AND CHEMICAL CORPORATION FELLOWSHIP—Open to students in ceramic technology for studies in ceramic technology; stipend \$1800.

KENNECOTT COPPER CORPORATION FELLOWSHIP—Open to graduate students in geophysics for studies relating to mining geophysics; stipend \$2400.

KOPPERS, INC., FELLOWSHIP (3) —Open to graduate students in chemistry; stipend \$2136.

LEAD INDUSTRIES FELLOWSHIP—Open to graduate students in ceramic technology for studies of lead oxide systems; stipend \$1800.

LITHIUM CORPORATION OF AMERICA FELLOWSHIP—For graduate students in ceramic technology for studies in inorganic lithium compounds and lithium oxide systems; stipend \$2400.

MONSANTO CHEMICAL COMPANY SUMMER FELLOWSHIPS IN CHEMISTRY—Open to graduate teaching assistants in chemistry for support of study during the summer terms; stipend \$650.

NATIONAL INSTITUTE OF HEALTH FELLOWSHIPS (6) —Open to graduate students in chemistry; stipend \$1800-\$2100.

EDWARD ORTON, JR., CERAMIC FOUNDATION FELLOWSHIP—Open to students in ceramic technology for studies relating to kiln-fired ceramic bodies; stipend \$1800.

OWENS-CORNING FIBERGLAS FELLOWSHIP IN INORGANIC CHEMISTRY—Open to a graduate student in inorganic chemistry for the final year of study leading to the Ph.D. degree; stipend \$3000.

PAN-AMERICAN FELLOWSHIP IN PETROLEUM AND NATURAL GAS ENGINEERING—Open to graduate students in petroleum and natural gas engineering for studies in petroleum production; stipend \$2000.

PENNSYLVANIA COAL RESEARCH BOARD FELLOWSHIP (2) —Available to graduate students in fuel technology; stipend \$2400-\$4000.

PENNSYLVANIA COOPERATIVE WILDLIFE ASSOCIATION (2) —Available to graduate students in forestry; stipend \$1560.

PENNSYLVANIA NATURAL GAS MEN'S FELLOWSHIP—For graduate work in petroleum and natural gas engineering for studies in gas technology; stipend \$2000.

PITTSBURGH PLATE GLASS FELLOWSHIP—Open to graduate students in ceramic technology for fundamental studies of glass; stipend \$3000.

ROCHESTER AND PITTSBURGH COAL FELLOWSHIP—Open to graduate students in mining engineering; stipend \$1575.



## FELLOWSHIPS

**SHELL FELLOWSHIP IN CHEMISTRY (2)**—Open to graduate students in the Department of Chemistry for the final year of study leading to the Ph.D. degree; stipend \$1800.

**SPEER CARBON FELLOWSHIP**—Open to graduate students in fuel technology for studies on carbon; stipend \$2400.

**SPRAGUE ELECTRIC COMPANY FELLOWSHIP**—Open to graduate students in ceramic technology for studies in the field of ceramic dielectrics; stipend \$2000.

**STACKPOLE FELLOWSHIP IN METALLURGY (2)**—Open to graduate students in metallurgy for studies in powder metallurgy; stipend \$2280.

**STACKPOLE CARBON COMPANY FELLOWSHIP**—Open to a graduate student in ceramic technology for research in ceramic ferrite materials; stipend \$3000.

**STAUFFER CHEMICAL COMPANY FELLOWSHIP IN CHEMISTRY**—Open to a graduate student in chemistry for research on organo-metallic compounds; stipend \$1780.

**SUN OIL COMPANY FELLOWSHIP IN CHEMISTRY**—Open to advanced graduate students in chemistry for study leading to the Ph.D. degree; stipend \$1800.

**TEXACO, INC., FELLOWSHIP**—Open to a graduate student in physics; stipend \$2400.

**UNION CARBIDE METALS FELLOWSHIPS (2)**—Open to graduate students in metallurgy; stipend \$2200.

**UNITED STATES DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE TRAINEESHIPS IN VOCATIONAL REHABILITATION COUNSELING (5)**—Open to graduate students in education who are specializing in rehabilitation counseling; stipend \$2400.

**UNITED STATES PUBLIC HEALTH SERVICE FELLOWSHIPS (7)**—Open to selected graduate students in clinical psychology; stipend \$1800-\$3000.

**UNITED STATES STEEL FOUNDATION FELLOWSHIP**—Open to graduate students in the College of Mineral Industries for studies related to steel-making; stipend \$2500.

**WEST PENN POWER COMPANY FELLOWSHIP**—Open to a graduate student in electrical engineering; stipend \$2000.

In addition, numerous grants are available from governmental agencies, industrial concerns, and foundations for the support of investigations of particular problems. Many of these permit full-time study and carry the same exemptions as the fellowships listed above. Detailed information may be secured from departments.

Among these are the National Science Foundation Predoctoral Fellowships for graduate study in physical sciences, mathematics, biological sciences, earth sciences, psychology, anthropology, and areas where natural sciences converge with social sciences. These fellowships are used at the university of one's choice, and application should be made to the National Science Foundation, Washington 25, D. C.

**DU PONT POSTGRADUATE TEACHING ASSISTANTSHIP IN CHEMISTRY**—Open to a graduate student in chemistry who has had two years' experience as a graduate teaching assistant.

**JOHN W. WHITE FELLOWSHIPS**—Awarded to two graduates of The Pennsylvania State University each year on the basis of scholarship, need, character, and attitude. The recipients may enroll in any approved college or university.

## OTHER STUDENT AIDS

**SCHOLARSHIPS**—A number of scholarships furnished by outside agencies and organizations are awarded annually through individual departments. A request for information should be directed to the department head in the field of the student's major interest.

**A.A.U.W. SCHOLARSHIP**—The State College Chapter of the American Association of University Women has established a modest scholarship which is awarded annually to honor an outstanding woman graduate student. The award does not include exemption from tuition. Nominations are made by departments.

**GRADUATE GRANTS-IN-AID**—Forty grants for full-time study are awarded each year, on a semester basis, providing for all tuition. They are available to any student on the basis of financial need and academic promise. A recipient is expected to carry a full program of graduate work, but may accept employment with the University or another employer not to exceed 10 hours per week, provided he reduces his academic load to 12 or 13 credits. Application for renewal of the grant-in-aid may be made for succeeding semesters. The value of these grants to Pennsylvanians is \$240 per semester, to non-Pennsylvanians \$480 per semester.

Applications should be addressed to the Dean of the Graduate School and must be received by March 1 to be considered for the following fall semester.

**LOAN FUNDS**—Funds are available from two sources: (1) University loan funds, in limited amounts; (2) loan funds received by the University under Title II of the National Defense Education Act of 1958. Graduate students who are classified as full-time students by the Dean of the Graduate School are eligible for a loan.

Information and application forms may be obtained from the Dean of Men or the Dean of Women.

**STUDENT EMPLOYMENT**—Many students depend upon part-time employment to help meet their expenses. A student who is thus employed, however, must recognize the time demands of his work schedule and will be required to adjust his academic load accordingly.

A student who holds a graduate assistantship or a fellowship may not accept employment, either at the University or elsewhere, during the period of his appointment.

The Student Employment Section of the University Placement Service, 112 Old Main, offers assistance to students in finding part-time employment in town as well as on the campus.

**VETERANS BENEFITS**—The Co-ordinator of Veterans Affairs has the responsibility of handling all applications for benefits under the various Public Laws.

Under P.L. 550 the responsibility for classifying students as to their rate of training rests with the Dean of the Graduate School. The classification is based on the extent to which the student devotes himself to his graduate program (as contrasted with the service for which he receives remuneration) and is not directly determined by the number of credits scheduled. Thus a student who is employed about 20 hours per week and devotes the remainder of his time to graduate work would be considered a half-time student on the basis of his employment regardless of how many credits he was permitted to schedule and regardless of his position, unless he be a graduate assistant. A quarter-time or a half-time graduate assistant is considered to be a full-time student and a three-quarter-time graduate assistant is considered to be a half-time student insofar as benefits under P.L. 550 are concerned.



**HEALTH CENTER**—The services of the University Health Center are available to graduate students registered for 12 or more credits and to all graduate assistants, fellows, and scholars.

Students are entitled to seven days' free treatment in the Hospital each semester. For each day of confinement in excess of one week a nominal charge of \$3 is made. Almost all modern drugs are furnished free of charge as required for treatment, but the student may be charged extra for medication where such treatment is unusual or extremely expensive. Consult the *Manual for Graduate Students* for details concerning facilities and services.

**INSURANCE PLAN**—A voluntary Accident and Sickness Insurance Plan with a variety of benefits is available to graduate students and their families. The Student Government Association, which operates the plan, has offices in the Hetzel Union Building.

**PLACEMENT SERVICE**—The University Placement Service co-ordinates the placement activities of all the Colleges and the Graduate School. It is available to any student who is in need of counseling or guidance on employment problems. The services of the following sections are available to the student without charge.

The General Placement Section functions primarily as a clearing house, bringing together students, alumni, faculty members, and representatives of organizations that are seeking college-trained personnel. Summer jobs other than those at camps or resorts are listed at this office.

The Teacher Placement Section assists seniors, alumni, and graduate students in all departments in securing teaching positions.

The Student Employment Section offers assistance to students in finding part-time employment in town and on the campus, as well as summer employment at camps and resorts. A student must be registered to be informed of jobs.

**RELIGIOUS PROGRAMS**—The University seeks to serve the spiritual needs of its students and staff. General responsibility for religious activity on the campus rests with the University Chaplain and Co-ordinator of Religious Affairs. Individual organizations under the sponsorship of members of the Jewish, Protestant, and Roman Catholic faiths serve the student body. Many other religious organizations, including denominational and interdenominational groups, are active on the campus and in association with local churches.

**STUDENT AFFAIRS**—The Graduate Student Association is the official University-wide organization of graduate students. All students enrolled during the academic year have membership in the Association, which promotes the general welfare and the academic interests of graduate students. It publishes the *Graduate School Newsletter*, maintains an up-to-date list of housing for graduate students, helps to sponsor the Graduate School lecture series, and sponsors social functions.

**SUMMER SESSIONS**—A series of sessions covering a period of 12 weeks is arranged each summer. During this time there are excellent opportunities for graduate work in many fields. Detailed information can be secured from the *Summer Sessions Complete Announcement*, which is published about April 1 and may be obtained by writing to the Dean of Summer Sessions.

It is the aim of the University to make available its staff and resources during the summer to aid students to the fullest possible extent in their programs of graduate study and research. The University cannot guarantee, however, that all the



## MASTERS' DEGREES

services normally offered during the academic year will be available during the summer.

To avoid disappointment, a student who plans to present a thesis for final consideration or to take the final doctoral examination during the summer sessions should inform the chairman of his committee and the head of his department of his intentions prior to June 1. A notice of approval will be sent to the student if the necessary staff members will be available to provide the service requested.

A graduate student desiring to carry forward a special graduate program or research project not officially listed as a part of the summer sessions should, likewise, obtain written approval of his plans from the chairman of his committee and the head of his department prior to June 1.

## MASTERS' DEGREES

The Graduate School recognizes a difference in purpose, which is reflected in the requirements, for two types of advanced degrees: academic and professional. Of the eight masters' degrees conferred, the Master of Arts and the Master of Science are academic in nature. The professional degrees conferred are Master of Agriculture, Master of Business Administration, Master of Education, Master of Engineering, Master of Forestry, and Master of Public Administration.

ADMISSION—Adequate undergraduate preparation is required in the field in which the applicant expects to pursue advanced work. The specific courses and the total number of undergraduate credits required in various areas will be determined by the choice of field and can be ascertained from the descriptive statement appearing under the major field heading in the latter portion of this bulletin. An applicant who meets the minimum grade point average but is deficient in course preparation may, under certain circumstances, be admitted to the Graduate School and allowed to make up the undergraduate deficiencies. Under these circumstances the program will require more than the minimum period of residence. An applicant for admission to the M.Ed. program is required to have had at least 18 credits in education and related psychology, and in certain major fields may be required to have had practice teaching.

## GENERAL REQUIREMENTS

A minimum of 30 graduate credits is required for a master's degree, except for the Master of Business Administration which requires at least 36 credits. All but 10 of the credits required in a program for the master's degree must be earned on the University Park Campus, except for the degree of Master of Engineering for which the requirements may be reduced by the major department.

All requirements for the degree, whether satisfied here or elsewhere, must be met within six years, or a period spanning seven consecutive summers. The student may complete the program as either a full-time or a part-time student and by attendance either during the academic year or during the summer.

The student should understand that a well-balanced, unified, and complete program of study will be required regardless of the minimum credit requirement. A degree is not conferred for a mere collection of credits. Many students find it necessary to earn more than the minimum number of credits before they are

regarded as being ready for the degree. In order to avoid possible disappointment the student should not think of the master's degree as a "one-year degree." The University is not committed to granting a degree upon completion of 30 credits.

After a student has been admitted as a regular graduate student, he should confer with the head of his major department concerning the appointment of an adviser. The general guidance of a master's candidate is the responsibility of an adviser, or of a committee appointed in a manner to be determined by the major department in which the student is specializing. The adviser or the committee assists the student in planning a program of study. Although the adviser is frequently the supervisor of the thesis, this is not necessarily the case.

Requirements concerning courses, language proficiency, minors, comprehensive examinations, and other matters are sometimes made by departments in addition to (but not in conflict with) the regulations of the Graduate School. For details the student should consult the head of the major department.

### M.A. AND M.S.—ADDITIONAL SPECIFIC REQUIREMENTS

The Master of Arts and the Master of Science degrees have similar requirements, the general major area determining which degree is conferred.

To fulfill degree requirements a candidate must present a major and either a minor field of study or an approved group of general studies. A minor consists of no fewer than 6 credits of integrated or articulated work in one field related to but different from that of the major. A general studies group consists of no fewer than 6 credits in fields other than that designated as the major field and considered by the major department to have significance and value for the candidate.

At least 18 credits in graduate courses (500 series) and thesis research (600 or 610) combined must be included in the program. A minimum of 12 credits in course work, as contrasted with research, must be completed in the major field and at least 6 credits must be devoted to a thesis.

The thesis is prepared under the direction of the department in which the candidate's major work is taken. Under certain conditions a student may complete the thesis off-campus. To do so he must make satisfactory arrangements in advance with both the major department and the Dean of the Graduate School.

A *Thesis Information Bulletin*, which gives details concerning format, paper, illustrations, and other items, may be obtained at the Graduate School office.

### M.AGR.—ADDITIONAL SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Agriculture has a professional orientation and provides training for increased competence in the various fields of agriculture. It should be clearly distinguished from the research-oriented program which leads to the academic degree of Master of Science.

A candidate is required to earn at least 12 credits in graduate courses (500 level) and a minimum of 12 credits outside his major field.

In addition to credit requirements, a candidate must present a paper on a selected professional problem comparable in quality to a thesis in which he applies scientific methods to the solution of a problem. Ability must be demonstrated to (a) formulate and state meaningfully the problem and objectives, (b) critically



## MASTERS' DEGREES

analyze the present state of knowledge of the problem, (c) acquire and analyze information to help solve the problem, (d) draw logical conclusions, and (e) interpret the relationship between findings and professional problems. The paper will be evaluated by a committee appointed by the Dean of the Graduate School.

The candidate is required to pass a final examination administered by a committee of three faculty members appointed by the Dean of the Graduate School with at least one member from a department other than that of the candidate's major field.

### M.B.A.—ADDITIONAL SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Business Administration is designed to develop advanced professional competence in the various fields of business administration. It should be distinguished carefully from the research-oriented programs which lead to the academic degree of Master of Science in Business Administration and Doctor of Philosophy with a major in Business Administration.

The program requires a minimum of 36 graduate credits of which at least 18 must be at the 500 level and at least 26 must be earned on the University Park Campus. Candidates who enter this program without undergraduate training in business administration may be required to take up to 21 credits of preparatory courses.

Moreover, a candidate is required to present a project paper, comparable in quality and scope of work to a graduate thesis, concerning a problem of a company. Approval of an appropriate committee of graduate faculty members is required for both the project proposal and the completed report.

After substantially completing his course requirements, a candidate must pass two examinations to be administered by committees composed of graduate faculty members. The first is a written comprehensive examination; the second is an oral one. During these examinations the candidate will be expected to demonstrate his ability to integrate the knowledge gained in the several functional areas of business in a manner which reflects a broad knowledge of his professional responsibilities.

Applicants for the various graduate programs in business administration are required to take the admission test for graduate study in business given by the Educational Testing Service.

### M.Ed.—ADDITIONAL SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Education provides preparation for increased professional competence in the several fields of education. It should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Arts or Master of Science.

A minimum of 24 credits must be earned in course work. The larger part of this shall be in 500 series courses. The needs of the student shall be considered in arranging the best combination of 400 and 500 series courses for the preparation of the candidate in his particular field.

When the candidate chooses a group major, his program of study will be approved by a standing committee which will serve in the same relation to him as does a department in the case of a student with a specific major.



**MAJOR AND MINOR FIELDS**—A student may major in one of the fields of education, such as elementary education, art education, or home economics education, with a minor in an area outside the fields of education. In this case the program is under the guidance of the appropriate department of education.

However, a student who is preparing to teach in a specific subject-matter area such as English, mathematics, or history may choose such a field as his major and take the majority of his work in it under the guidance of that department. In this case the student is required to have a minor consisting of no fewer than 6 credits in education. All candidates are required to take the examination in educational foundations which is administered by the Department of Educational Services. If adequate background is demonstrated, the candidate may then minor in any field of education. If adequate background is not demonstrated, the minor must be in educational foundations, which includes the following specific courses in comparative education, educational measurements and statistics, educational psychology, history of education, and philosophy of education: Ed.Ser. 417, 418, 490, 494, 516, 517, 522, 590; and Psy. 414, 502, 513, 514.

A student wishing to work in a broader field may choose a group major, such as social studies, physical science, or biological science. In this case, at least 24 credits are to be devoted to the group, and at least 6 to a minor in education. It is expected that each student will choose one subject of the group as a field of primary interest, to which at least 12 credits are to be devoted. All candidates are required to take the examination in educational foundations which is administered by the Department of Educational Services. If adequate background is demonstrated, the candidate may minor in any field of education; if not, the minor is restricted to educational foundations.

A student who is majoring in educational administration or in counseling in education may minor in either educational foundations or in a field outside of education. A minimum of 6 credits is required.

A candidate majoring in one of the fields of education is required to take a departmental diagnostic examination which serves as a guide in outlining a program of study that will fit his individual needs.

**THESIS OR TERM PAPER**—Six credits may be granted for an approved thesis. Those candidates who do not elect to write a thesis are required to present an essay or term paper. It must be of considerable proportion, indicating capacity to describe a serious intellectual experience adequately in writing, and giving unmistakable evidence of ability to formulate and state meaningfully the purpose of an investigation, study, critical analysis, or evaluation; to acquire and analyze information; to draw conclusions logically; and to relate findings to professional problems and practices. The nature and extent of such a piece of writing, whether it be required in connection with a course or independently of course work, and when it is to be undertaken shall be determined by the major department. The department shall report to the Dean of the Graduate School the title, the name of the faculty member under whom the student did the work, and whether the work was considered adequate. It is the right, but not the responsibility, of the department to require one or more copies of such an essay for its library or other files.

Candidates for the Master of Education degree must pass a final comprehensive examination. The examination will be designed to determine the ability of the candidate to apply the general as well as the special knowledge of his chosen field to practical situations.

## MASTERS' DEGREES

### M.ENG.—ADDITIONAL SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Engineering provides training for advanced professional competence in the several fields of engineering. It should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Science.

At least 12 credits must be earned in graduate courses (500 series), and a minimum of 6 credits must be earned outside the candidate's field of concentration.

A scholarly written report on a developmental study involving at least one area represented in the candidate's course work is required as an integral part of the program. The report must be comparable in its level of work and quality to a graduate thesis.

No work for this degree is required to be done specifically on the University Park Campus provided the major department or supervisory committee agrees that a suitable program can be pursued elsewhere.

### M.F.—ADDITIONAL SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Forestry provides training for increased professional competence in the several specialized areas of forestry and wood utilization. It should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Science with a major in forestry.

A candidate for the degree of Master of Forestry should choose one area for his major and one or two related areas for his minor. The proportion of credits to be taken in the major and minor fields of study will be determined in consultation with the student's advisory committee. It is expected that the larger part of the program shall be in graduate courses (500 series), but no specific number of credits in the 500 series is required.

Each candidate is required to prepare and submit an acceptable thesis. At least 6 credits of thesis work is required.

### M.P.A.—ADDITIONAL SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Public Administration provides pre-service training for students planning to enter the field of public administration at the national, state, or local level.

The program covers a 12-month period and consists of two semesters of work on campus, followed by an internship of six weeks in some governmental agency. The course of study is made up of subject blocks, such as organization, management, personnel administration, budgeting, finance, accounting, public works administration, administrative law, planning, statistics, report writing, speech, and public relations. The student has a major in public administration and a minor in either public finance or public works, depending upon his interest.

In lieu of a thesis, the student is required to submit an extensive written report on a project which has been carried out during his internship.

This degree is a terminal one and cannot be applied toward a doctorate.



## DOCTORAL DEGREES

The Doctor of Philosophy, an academic degree, and the Doctor of Education, a professional degree, are conferred. The two programs are recognized as different in purpose and consequently have different requirements in certain respects.

**ADMISSION**—A student who meets the general requirements for admission to the Graduate School and has been accepted by the department or committee in charge of a major field in which the doctorate is offered, may begin working toward that degree. However, he has no official status as a doctoral student and has no assurance that he will be accepted as a doctoral candidate until he has passed a candidacy examination. This examination is administered by the major department and is given near the end of the first, or at the beginning of the second, year of graduate work including that done for the master's degree and work done elsewhere as well as here (i.e., at about the time he has earned a total of 30 graduate credits).

A new student transferring from another graduate school with 30 or more transfer credits must take this examination before he has earned more than 10 credits here.

**GENERAL REQUIREMENTS**—No specified number of courses completed or credits earned will assure the attainment of the doctorate. The general requirements are based upon a period of residence, the passing of comprehensive examinations, and the writing of a satisfactory thesis. A doctoral program consists of such a combination of courses, seminars, and individual study and research as meets the minimum requirements of the Graduate School and is approved by the doctoral committee for each individual student. It includes work in a major field of study and in either a minor field or a group of general studies.

**RESIDENCE REQUIREMENTS**—A minimum of three academic years of full-time graduate study and research, or their equivalent in credits, is required for a doctor's degree.

At least 30 credits must be earned in residence at the University Park Campus. For the Ph.D. degree a candidate must earn the minimum of 30 credits in residence in regular semesters, and for at least two semesters his work load must be limited to half-time at most, the balance of his time being devoted to graduate study. For the D.Ed. degree, the minimum residence requirement may be met by attendance at summer sessions, although there is no guarantee that it will be possible to do so in all cases.

The first year of graduate study leading to the doctor's degree may be substantially the same as that provided for the master's degree, although a master's degree is not a prerequisite for the doctorate.

**OFF-CAMPUS AND TRANSFER CREDITS**—A maximum of two full academic years of residence work in another approved school granting the doctorate in the major field may be accepted by the Graduate School in partial fulfillment of the requirements for a doctoral degree at The Pennsylvania State University. Not more than one year of residence at a graduate school not granting the doctorate in the major field will be accepted here to apply toward doctoral degree requirements. Credit for courses and research work done elsewhere can be used to meet degree requirements, however, only if the work is appropriate to the candidate's proposed program of study as determined by his doctoral committee.

By securing the maximum allowable number of transfer credits, it is possible theoretically to complete the requirements at this institution in one academic



## DOCTORAL DEGREES

year. In practice, however, this is rarely possible because of the sequence required in courses and examinations, special departmental requirements, and the possibility of protracted research. It must be remembered that the quality of the program rather than the time requirement is of paramount concern.

Subject to the approval of his adviser, the head of his major department, and the Dean of the Graduate School, a student may register for research to be done away from the University Park Campus. Such work will not be approved, however, simply because the arrangement is convenient for the student; scholarly considerations must determine the choice of location. A doctoral candidate may register for a maximum of 30 credits of research *in absentia*, but these credits must be included in the 60 credits (two academic years) which a candidate may earn in study away from the University Park Campus. The maximum load permitted a student who is employed full time is 6 credits in a semester and 5 credits distributed over the 12 weeks of the summer.

A candidate for a doctor's degree may apply toward the minimum requirements a maximum of 10 credits earned in approved classes in Continuing Education or at the Commonwealth Campuses of The Pennsylvania State University.

**ADVISERS AND DOCTORAL COMMITTEES**—After a student has been admitted as a regular graduate student, he should confer with the head of his major department concerning departmental procedures and the appointment of an adviser. The arrangement and approval of the details of the semester-by-semester schedule of the student is the function of the adviser. This person may be a member of the doctoral committee or someone else designated by the head of the major department for this specific duty.

The general guidance of a doctoral candidate is the responsibility of a doctoral committee consisting of five or more members of the Graduate Faculty. The committee is appointed by the Dean of the Graduate School, upon recommendation of the head of the major department, at the time the student is admitted to candidacy. The chairman of the committee must hold full membership in the Graduate Faculty. The supervisor of the candidate's thesis will usually, but not necessarily, be designated as chairman. At his discretion, the Dean may add additional members to the committee.

The doctoral committee is responsible for establishing the broad outline of the student's program and should review the program as soon as possible after admission to candidacy. The committee will prepare, give, and evaluate the candidate's examinations, and supervise and approve his thesis. A favorable vote of at least two-thirds of the members of the committee is required for passing a comprehensive or a final examination. If a candidate fails an examination, it is the responsibility of the doctoral committee to determine whether he may take another examination.

The committee will also notify the Dean when the candidate is ready to have his comprehensive and his final examination scheduled and will report the results of these examinations to the Dean.

**LANGUAGE EXAMINATIONS**—Candidates for the D.Ed. degree are not required to demonstrate a reading knowledge of a foreign language unless a special requirement is set up by the major department.

For the Ph.D. degree, the candidate is required to have a reading knowledge of at least two foreign languages. German and French are the languages most often needed. Other languages may be presented instead of these, if their choice is determined by scholarly and professional reasons. The choice of a language must be

## DOCTORAL DEGREES

approved by the major department. If a language other than English, French, German, Italian, Russian, or Spanish is presented, it must be approved also by the Dean of the Graduate School. A student may not present his "mother tongue" as one of the two languages required in candidacy.

An important value of the foreign language training lies in the need to introduce the student to the non-English literature of a subject, and to make possible the use of this literature both during graduate training and during his subsequent professional career. The candidate for a degree therefore should prepare early in his graduate program to meet the foreign language requirements.

The language examinations are administered by the respective language departments of the University and are held three times each year, once during each semester and once during the Mid-Session. Specific dates may be obtained from the language department or from the calendar beginning on page 3 of this publication. So as to determine adequacy of preparation for the regular examination, every candidate is required to present himself to the language department concerned for a preliminary test in oral translation, not to exceed 15 minutes duration, either during Orientation Week of the Fall or Spring Semester, or during the first week of the Mid-Session. A candidate is allowed only one such preliminary examination.

Certificates of proficiency must be obtained if language requirements have been met at another institution prior to admission to the Graduate School at Penn State. In this case it is the general policy to require a letter from the Graduate Dean of the institution in which the foreign language examination was taken, stating that the examination taken by the student was that required of prospective Ph.D. candidates. Other evidence, such as examinations here, may also be required. (See the *Manual for Graduate Students* regarding the nature of the examination and registration therefor.)

**COMPREHENSIVE EXAMINATIONS**—A candidate for the Ph.D. or D.Ed. degree is required to take a comprehensive examination covering his major and minor fields to determine if he has adequate mastery of the subject matter to entitle him to proceed to the completion of a thesis.

This examination will normally be taken when the candidate has substantially completed his course work. In no case may the final examination be scheduled less than three months after the comprehensive examination. The comprehensive examination is to be given and evaluated by the doctoral committee and may be either written or oral, or both. A favorable vote of at least two-thirds of the members of the committee is required for passing. In case of failure, it is the responsibility of the doctoral committee to determine if he may take another examination. The results are reported to the Dean of the Graduate School.

A candidate for the degree of Doctor of Philosophy must have satisfied the language requirements before taking the comprehensive examination.

**FINAL ORAL EXAMINATIONS**—The doctoral candidate who has satisfied all other requirements for the degree will be scheduled, on recommendation of the doctoral committee, to take a final examination. In no case may the final examination be scheduled less than three months after the comprehensive examination. The deadline for holding the examination is three weeks before Commencement.

The final examination is oral, open to the public, and related in large part to the thesis; but it may cover the whole field of study of the candidate without regard to courses that have been taken either here or elsewhere.

A favorable vote of at least two-thirds of the members of the committee is re-



## DOCTORAL DEGREES

quired for passing. The results of the examination are reported to the Dean of the Graduate School and will be entered upon the candidate's official record. If a candidate fails, it is the responsibility of the doctoral committee to determine if he may take another examination.

### PH.D.—ADDITIONAL SPECIFIC REQUIREMENTS

The degree of Doctor of Philosophy is conferred in recognition of high attainment and productive scholarship in some special field of learning as evidenced by (1) the satisfactory completion of a prescribed period of study and investigation, (2) the preparation of a thesis involving independent research, and (3) the successful passing of examinations covering both the special subject and the general field of learning of which this subject forms a part.

The program for the Ph.D. includes a major and either a minor or a group of general studies. Approximately two-thirds of the total time is to be devoted to the major field. A minor consists of no fewer than 15 credits, including those applied toward the master's degree, of integrated or articulated work in one field related to, but different from, that of the major. A general studies group consists of no fewer than 15 credits, including those applied toward the master's degree, in fields other than that designated as the major field and considered by the major department to have significance and value for the candidate.

**THESIS**—The ability to do independent research and competence in scholarly exposition must be demonstrated by the preparation of a thesis on some topic related to the major subject. It should represent a significant contribution to knowledge, be presented in a scholarly manner, reveal on the part of the candidate an ability to do independent research of high quality, and indicate considerable experience in using a variety of research techniques. The contents and conclusions of the thesis must be defended at the time of the final examination.

The completed thesis together with an abstract, typewritten in triplicate, must be filed in the office of the Dean of the Graduate School not later than two weeks prior to the commencement at which the candidate expects to receive the degree.

A *Thesis Information Bulletin*, which gives details concerning format, paper, illustrations, and other items, may be obtained at the Graduate School office.

### D.ED.—ADDITIONAL SPECIFIC REQUIREMENTS

The degree of Doctor of Education is conferred in recognition of advanced preparation of a high order for work in the profession of education as evidenced by (1) the satisfactory completion of a prescribed period of study; (2) ability to apply scientific principles in classroom instruction, supervision of instruction, administration, or as a consulting specialist in certain educational areas; (3) preparation of a thesis demonstrating ability to undertake an educational problem with originality and independent thought; (4) successfully passing examinations showing a satisfactory grasp of the field of specialization and its relation to allied educational areas; and (5) showing recognized potential for leadership in the profession of education.



## DOCTORAL DEGREES

Every candidate must show, through comprehensive examinations, that he is familiar with current theories of education; that he understands and can apply the techniques and the findings of educational research so far as they bear upon the teaching of his subject; that he is prepared to read understandingly and contribute to the technical and professional literature in his field; and that he can criticize his own procedures in the light of historical trends and practices in this and other countries. Command of the tools for a thorough study of the problems of education is necessary and must include familiarity with statistical methods. For certain students the requirements may include a reading knowledge of one or more foreign languages.

**MAJOR AND MINOR FIELDS**—The program of study includes a major and either a minor or a group of general studies. A majority of the courses offered in fulfillment of the requirements must be in the major field of study.

A candidate choosing a major outside the fields of education (such as chemistry, English, or history) shall have a minor consisting of no fewer than 15 credits, including those applied toward the master's degree, in psychology and educational foundations, which includes the following specific courses in comparative education, educational measurements and statistics, educational psychology, history of education, and philosophy of education: Ed.Ser. 417, 418, 490, 494, 516, 517, 522, 590; and Psy. 414, 502, 513, 514.

A candidate choosing a major in one of the fields of education must also choose either a minor or a group of general studies with the approval of the major department. In this case a minor consists of no fewer than 15 credits, including those applied toward the master's degree, in one field outside the fields of education. An acceptable general studies group consists of no fewer than 15 credits, including those applied toward the master's degree, in fields outside the fields of education considered by the major department to have significance and value for the candidate.

**THESIS**—Evidence of a high degree of scholarship, competence in scholarly exposition, and ability to select, organize, and apply knowledge must be presented by the candidate in the form of a written thesis. The candidate must demonstrate a capacity for independent thought as well as ability and originality in the application of educational principles or in the development of new generalizations under scientific controls. The thesis may be based upon a product or project of a professional nature, provided that scholarly research is involved. For example, it may be based upon the solution of a professional problem concerned with the development of a curriculum, or a product of creative effort related to education. However, in order to be acceptable as a thesis, the professional project must be accompanied by a written discourse demonstrating the nature of the research and including such theories, experiments, and other rational processes as were used in effecting the final result. The topic and outline of the proposed thesis must have the approval of the doctoral committee.

The completed thesis together with an abstract, typewritten in triplicate, must be filed in the office of the Dean of the Graduate School not later than two weeks prior to the commencement at which the candidate expects to receive the degree.

A *Thesis Information Bulletin*, which gives details concerning format, paper, illustrations, and other items, may be obtained at the Graduate School office.

## TECHNICAL DEGREES

The degrees conferred are Fuels Engineer, Ceramic Engineer, Engineer of Mines, Metallurgical Engineer, and Petroleum Engineer.

**ADMISSION**—A graduate of the College of Mineral Industries of this University may be admitted to work for a technical degree, provided he submits evidence of having been engaged for a period of not less than three years in acceptable professional work in the field in which the application for the degree is made.

A technical degree may also be granted to an engineer of approved practical experience who is a graduate in engineering of another institution of equal standing, on completion of at least three years of full-time teaching or research work in engineering in a professional rank in this institution, and upon presentation of an acceptable thesis and the fulfillment of all other requirements for technical degrees.

An applicant for a technical degree must file with the Dean of the Graduate School an application filled out in duplicate on the prescribed forms, approved by the head of the department in which the undergraduate work was completed. The application should be accompanied by the admission fee of \$10.

**REQUIREMENTS**—Not less than three years shall have elapsed from the time of receiving the first degree before a graduate of this institution shall be permitted to file his application for a technical degree. The application for a technical degree shall include evidence of a satisfactory professional record, which must be approved by the executive committee of the undergraduate College concerned.

Registration for these degrees is the same as for resident students. A candidate must be registered during two regular semesters.

In order to be recommended for a technical degree, the candidate must prepare a thesis on a subject related to his profession, and he may be required to appear in person to defend his thesis.

**THESIS**—Immediately following registration the candidate must submit for approval an outline of his proposed thesis; and at least six weeks prior to the day on which the degree is to be conferred, the complete thesis must be in the office of the head of the department concerned.



# PROGRAMS AND COURSES

Programs of study leading to advanced degrees are offered in many major and minor fields. These are listed in the following section, and the major fields are summarized on page 54. Related courses are grouped together under the name of the field. To locate a particular or group of courses consult the index.

In general, departments of the University are identified with specific major fields. Thus aeronautical engineering is a major field of study which is offered under the supervision of the Department of Aeronautical Engineering. On the other hand, biological science and comparative literature are major fields for which there are no corresponding departments. In such cases a committee of the Graduate School is responsible for administering the program. In some cases a single department offers work in more than one field. Thus the Department of Civil Engineering offers work in both civil and sanitary engineering.

Applicants for admission are encouraged to consult the person whose name is listed under the major field heading.

**DEGREES**—In those major fields approved for the doctorate the Ph.D. is normally conferred, although a program leading to the D.Ed. may also be arranged with the consent of the department or committee in charge if such a professional program is appropriate. Similarly in major fields approved for the master's degree the M.A. or M.S. is normally conferred, but a program leading to the M.Agr., M.B.A., M.Ed., M.Eng., or M.P.A. may also be available. The D.Ed. and M.Ed. are not limited to the fields of education, but with the consent of the department or committee in charge may be offered in any approved major field appropriate to the preparation of teachers, such as chemistry or English. In this case the program is sponsored by a major department outside the fields of education, such as the Department of Chemistry, but the student's minor is in education.

**MINOR FIELDS**—All major fields listed are also acceptable as minors. In addition, a few fields in which no advanced degrees are offered have been approved as minors for candidates who are majoring in related areas. Such minor fields are identified by a brief statement under the field heading.

A candidate's choice of minor field depends upon the particular degree he is seeking and is subject to the approval of his major department. The requirements in each minor field are established by the minor department subject to the regulations of the Graduate Faculty.

**INTERDISCIPLINARY MAJORS**—In addition to the majors listed on page 54, interdisciplinary majors involving two or more departments may be arranged with the approval of the Dean of the Graduate School. These programs are offered under the supervision of appropriate interdepartmental committees.

**OTHER FIELDS**—Fields which have not been approved for either major or minor work, but in which approved courses are offered, are listed in Part II of this bulletin. These courses may be used in graduate programs as electives or as part of a general studies program, subject to the approval of the major department and to the restrictions upon the use of 400 series courses in degree programs.

**COURSE NUMBERING SYSTEM**—Courses in the series 1-399 are not listed in this bulletin because they are strictly undergraduate courses and yield no graduate credit. A graduate student may register for or audit these courses in order to make up deficiencies or fill in gaps in his earlier education but not to meet requirements for an advanced degree.



## PROGRAMS AND COURSES

Courses in the series 400-499 are for upperclassmen with at least junior standing and for graduate students. Only a limited number of credits earned in these courses may be counted toward the requirements for an advanced degree. Detailed regulations are given in the preceding section of this bulletin.

Courses in the series 500-599 are restricted to students registered in the Graduate School, seniors with an average of at least 3.5, and other students who have been granted permission to enroll by the Dean of the Graduate School.

Course numbers 600 and 610 apply to thesis research and are available only to students registered in the Graduate School.

**COURSE DESCRIPTIONS**—A course abbreviation, a number, and a title designate each course. Course designations and official abbreviations are listed at the left-hand margin just above the first course in each group. The figures in parentheses following the course title show the number of credits which may be granted for that course. In the case of courses with variable credits, the number of credits which may be earned in a single semester or session is determined by the department offering the course.

A department may schedule an entire section of a course below the 400 level for fewer credits than the maximum authorized. In 400 and 500 series courses a department may schedule an individual student for fewer credits than the maximum number but in no case for more than the maximum number authorized.

**SCHEDULE OF COURSES**—Not all courses are given each semester or session. A complete list of the courses which will be offered in any specific semester is given in the *Timetable*, which is available at nominal cost from the Registrar's Office a few weeks before the beginning of each semester. The *Timetable* gives the number of credits being offered in each course, the hours at which the class will meet, the location of the class, and in some cases the instructor's name.

The courses being offered during a specific summer session are given in the *Complete Announcement of the Summer Sessions* for that year. This announcement, which includes a timetable for summer sessions classes, may be obtained from the Summer Sessions office a few weeks before the beginning of the first session.

The list of courses given in the *Timetable* and the *Complete Announcement of the Summer Sessions* is subject to modification at registration time. The number enrolling in a course, the availability of staff members, and other circumstances may result in the cancellation of some courses and the offering of others. Decisions are made by the departments offering the courses.

**RESEARCH AND THESIS WORK**—In general, students registering for work on a master's or a doctor's thesis will, if it is to be done on the University Park Campus, use course number 600 preceded by the appropriate abbreviation. Thus Aro.E. 600 signifies thesis research in aeronautical engineering. In case such work has been authorized for students not working on the University Park Campus, the number 610 will be used. Credits will be 1 to 15 per semester.

It should be assumed that the numbers 600 and 610 are available during the academic year in all fields in which majors have been approved for advanced degrees although these numbers do not appear in the timetables. In the summer, however, research and thesis work are usually available only in those fields for which 600 and 610 numbers appear in the *Complete Announcement* and the *Summer Sessions Timetable* for that year.

MAJOR  
and  
MINOR  
FIELDS

## FIELDS IN WHICH GRADUATE DEGREES ARE OFFERED

Aeronautical Engineering, Ph.D., M.S., M.Eng.	History, Ph.D., D.Ed., M.A., M.Ed.
Agricultural and Biological Chemistry, Ph.D., M.S.	Home Economics Education, Ph.D., D.Ed., M.S., M.Ed.
Agricultural Economics, Ph.D., M.S.	Home Economics, General, Ph.D., D.Ed., M.S., M.Ed.
Agricultural Education, Ph.D., D.Ed., M.S., M.Ed.	Home Management and Family Economics, Ph.D., D.Ed., M.S., M.Ed.
Agricultural Engineering, M.S.	Horticulture, Ph.D., M.S.
Agronomy, Ph.D., M.S., M.Agr.	Industrial Arts Education, Ph.D., D.Ed., M.S., M.Ed.
Animal Husbandry, Ph.D., M.S.	Industrial Engineering, M.S., M.Eng.
Animal Nutrition, Ph.D., M.S.	Institution Administration, M.S.
Architectural Engineering, M.S.	Journalism, M.A.
Architecture, M.S.	Mathematics, Ph.D., D.Ed., M.A., M.Ed.
Art, M.A.	Mechanical Engineering, Ph.D., M.S., M.Eng.
Art Education, Ph.D., D.Ed., M.S., M.Ed.	Metallurgy, Ph.D., M.S.
Bacteriology, Ph.D., M.S.	Meteorology, Ph.D., M.S.
Biological Science, D.Ed., M.Ed.	Mineral Economics, Ph.D., M.S.
Botany, Ph.D., M.S.	Mineral Preparation, Ph.D., M.S.
Business Administration, Ph.D., M.S., M.B.A.	Mineralogy and Petrology, Ph.D., M.S.
Business Education, Ph.D., D.Ed., M.S., M.Ed.	Mining Engineering, Ph.D., M.S.
Ceramic Technology, Ph.D., M.S.	Music, M.A.
Chemical Engineering, Ph.D., M.S.	Music Education, D.Ed., M.Ed.
Chemistry, Ph.D., D.Ed., M.S., M.Ed.	Nuclear Engineering, M.S., M.Eng.
Child Development, Ph.D., D.Ed.	Nutrition, Ph.D., D.Ed., M.S., M.Ed.
Child Development and Family Relationships, M.S., M.Ed.	Nutrition in Public Health, M.S.
Civil Engineering, Ph.D., M.S., M.Eng.	Petroleum and Natural Gas Engineering, Ph.D., M.S.
Clinical Speech, Ph.D., D.Ed., M.S., M.Ed.	Philosophy, Ph.D., M.A.
Clothing and Textiles, Ph.D., D.Ed., M.S., M.Ed.	Physical Education, Ph.D., D.Ed., M.S., M.Ed.
Comparative Literature, Ph.D., M.A.	Physical Science, D.Ed., M.Ed.
Counseling in Education, Ph.D., D.Ed., M.S., M.Ed.	Physics, Ph.D., M.S.
Dairy Science, Ph.D., M.S.	Plant Pathology, Ph.D., M.S.
Economics, Ph.D., M.A.	Political Science, Ph.D., M.A., M.P.A.
Educational Administration, Ph.D., D.Ed., M.S., M.Ed.	Poultry Husbandry, Ph.D., M.S.
Electrical Engineering, Ph.D., M.S., M.Eng.	Psychology, Ph.D., D.Ed., M.S., M.Ed.
Elementary Education, Ph.D., D.Ed., M.S., M.Ed.	Public Administration, M.P.A.
Engineering Mechanics, Ph.D., M.S., M.Eng.	Recreation Education, Ph.D., D.Ed., M.S., M.Ed.
English, Ph.D., M.A.	Romance Languages and Literatures, Ph.D., M.A.
Entomology, Ph.D., M.S.	Rural Sociology, Ph.D., M.S.
Family Relationships, Ph.D., D.Ed.	Sanitary Engineering, M.S., M.Eng.
Foods, M.S., M.Ed.	Secondary Education, Ph.D., D.Ed., M.S., M.Ed.
Forestry, M.S., M.F.	Social Studies, M.Ed.
Fuel Technology, Ph.D., M.S.	Sociology, Ph.D., M.A.
Genetics and Breeding, Ph.D., M.S.	Speech, Ph.D., D.Ed., M.A., M.Ed.
Geochemistry, Ph.D., M.S.	Theatre Arts, M.A.
Geography, Ph.D., D.Ed., M.S., M.Ed.	Vocational Industrial Education, Ph.D., D.Ed., M.S., M.Ed.
Geology, Ph.D., M.S.	Wildlife Management, M.S.
Geophysics, Ph.D., M.S.	Zoology, Ph.D., M.S.
German, Ph.D., M.A., M.Ed.	
Higher Education, D.Ed.	

The degrees listed above are the ones normally conferred in each of the designated major fields. Additional professional degrees, including the M.Agr., M.Ed., and M.Eng., have been authorized in many cases and may be offered at the discretion of the department head and the Dean of the Graduate School. Thus, the M.Ed. has been authorized for all of the above fields in which a master's degree is conferred provided the field is appropriate to the preparation of teachers.



## Part I

### *Courses in Major and Minor Fields*

## AERONAUTICAL ENGINEERING

IRVING MICHELSON, *Head of the Department*  
203 Engineering D

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Professors Michelson, Wislicenus, and Yeh (Visiting Professor); Assistant Professor Li.

Course work and research are available in the following areas: classical and modern hydro-, aero-, and gas-dynamics, including aerochemistry and magneto-hydrodynamics; structures; aeroelasticity; turbo-machinery, advanced propulsion; low-speed flight.

The entering student must hold a bachelor's degree in science, mathematics, or engineering and must have completed undergraduate course work in fluid and solid mechanics and in intermediate mathematical analysis.

### AERONAUTICAL ENGINEERING (ARO E)

401a,b,c. AERONAUTICAL ENGINEERING PROJECTS (2-12)

402. PROPULSION SYSTEMS DESIGN (3)

403. APPLIED AERODYNAMICS (3)

404. AIRPLANE AND MISSILE DESIGN (3)

407. DYNAMICS OF LOW-SPEED FLIGHT (3)

408. AERONAUTICAL AND ASTRONAUTICAL TURBOMACHINERY (3)

409. ADVANCED AIRCRAFT STRUCTURES (3)

410. AIRCRAFT AND SPACE PROPULSION (3)

411. AEROELASTICITY (3)

412. THEORETICAL AERODYNAMICS (3)

413. AERONAUTICAL DYNAMICS (3)

414. GASDYNAMICS (3)

415. ADVANCED THEORETICAL FLUID DYNAMICS (3-6)

416-417. AERO-SPACE SEMINAR (1 each)

501. AIRPLANE STABILITY AND CONTROL (3) General analysis of longitudinal and lateral stability of airplanes; characteristics of flight control devices. Prerequisite: Aro.E. 403.

503. AIRPLANE PERFORMANCE (3) Methods of performance prediction and performance flight testing for high-speed aircraft and missiles. Prerequisite: Aro.E. 403.

504. ROTARY WING AIRCRAFT (3) Types of rotary wing aircraft; helicopter performance, stability, and control; structural and vibration problems. Prerequisites: Aro.E. 403, 409.

## AERONAUTICAL ENGINEERING

505. AEROELASTICITY (3) Vibrating systems with several degrees of freedom; analysis of flutter speed of an airplane wing considering bending, torsion, and aileron motions; other types of aircraft flutter. Prerequisites: Aro.E. 412; E.Mch. 401 or Aro.E. 411.
506. AIRCRAFT STRUCTURES (3-9) Deflections of beams and trusses; statically indeterminate structures; shear-flow analysis and shearing deformations of multicell semi-monocoque structures; effects of discontinuities in wing and fuselage structures. Prerequisites: Aro.E. 409, E.Mch. 408.
507. AIRCRAFT GAS TURBINES AND JET PROPULSION ENGINES (3) Types of jet propulsion installations, thermodynamic cycles, analysis of compressors, combustion chambers, and turbines. Prerequisite: Aro.E. 410.
510. AERODYNAMICS OF COMPRESSIBLE FLUIDS (3) One-dimensional motion, shock waves, flow in nozzles, two-dimensional flow, airfoil theory, Prandtl-Meyer flow, method of characteristics. Prerequisite: Aro.E. 412.
511. AERODYNAMICS OF A PERFECT FLUID (3) Euler's dynamic equations, complex potential, conformal transformation, thin airfoils, Biot-Savart law; Prandtl three-dimensional airfoil theory. Prerequisite: Aro.E. 412.
512. AERODYNAMICS OF A VISCOUS FLUID (3) Navier-Stokes equations, incompressible and compressible boundary layer theory, jet and wake problems, hydrodynamic stability, turbulence. Prerequisite: Aro.E. 412.
513. RESEARCH IN AERONAUTICAL ENGINEERING (1-15 per semester) Investigation of a theoretical or experimental project in aeronautical engineering.
514. AERONAUTICAL ENGINEERING SEMINAR (1 per semester) Current literature and special problems in aeronautical engineering.
515. AERODYNAMICS (3) Airflow, airplane performance. For students with undergraduate training in science or engineering curriculums other than aeronautical engineering.
516. SPECIAL TOPICS IN AIRCRAFT STRUCTURES (3-9)
519. FLUID DYNAMICS OF ROTATING MACHINERY (3-6) Prerequisite: Aro.E. 412.
520. SPECIAL TOPICS IN AERODYNAMICS (3-9)

## AGRICULTURAL AND BIOLOGICAL CHEMISTRY

HOWARD O. TRIEBOLD, *Head of the Department*  
109 Frear Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Althouse, Boucher, Clagett, Frear, Guerrant, Pritham, Sullivan, and Triebold; Associate Professors Benson and Mallette; Assistant Professor Shigley.

Opportunities for research and graduate study are available in plant metabolism and photosynthesis, intermediary metabolism, nucleic acids, proteins, carbohydrates, lipides, enzymes, vitamins, animal nutrition, poultry nutrition, clinical chemistry, endocrinology, and pesticides.

## AGRICULTURAL AND BIOLOGICAL CHEMISTRY

Entering graduate students should have had at least one year's work in each of the following: general chemistry, analytical chemistry, organic chemistry, physical chemistry, and general physics. Mathematics through integral calculus is also required. Students with limited deficiencies in these subjects may be admitted but must make up such deficiencies concurrently with their graduate studies. Undergraduate courses in biology, biochemistry, and foreign languages will be helpful to the student but are not required for admission.

### AGRICULTURAL AND BIOLOGICAL CHEMISTRY (AB CH)

- |                                                     |                                     |
|-----------------------------------------------------|-------------------------------------|
| 401. GENERAL BIOCHEMISTRY (4)                       | <i>Mr. Clagett</i>                  |
| 402. GENERAL BIOCHEMISTRY (4)                       | <i>Mr. Clagett</i>                  |
| 403. DAIRY CHEMISTRY (3)                            | <i>Mr. Shigley</i>                  |
| 404. FOOD CHEMISTRY (4)                             | <i>Mr. Triebold</i>                 |
| 413. PRINCIPLES OF ANIMAL NUTRITION (3)             |                                     |
| 417. METHODS OF AGRICULTURAL ANALYSIS (4)           | <i>Messrs. Triebold and Clagett</i> |
| 425. BIOPHYSICAL CHEMISTRY (4)                      | <i>Mr. Mallette</i>                 |
| 426. BIOCOLLOIDS (3)                                | <i>Mr. Mallette</i>                 |
| 437. PHYSIOLOGICAL CHEMISTRY (5)                    | <i>Mr. Pritham</i>                  |
| 438. PHYSIOLOGICAL CHEMISTRY (CLINICAL METHODS) (5) | <i>Mr. Pritham</i>                  |
| 439. PROBLEMS IN AGRICULTURAL CHEMISTRY (3-5)       |                                     |
| 440. PLANT BIOCHEMISTRY (3)                         | <i>Mr. Clagett</i>                  |
| 441. RADIOLOGICAL SAFETY (1)                        |                                     |
501. ENZYMES (2) Investigations and theories concerning nature of enzymes, enzyme action, influence of chemical environment on enzyme action, and biological applications. Prerequisite: A.B.Ch. 437. Fall semester. *Mr. Clagett*
503. BIOCHEMICAL PROBLEMS (1-10 per semester) Prosecution of an assigned problem under the guidance of an instructor. Each semester and summer session.
505. VITAMINS AND DIETARY DEFICIENCY DISEASES (2) Lectures, conferences, and assigned reading. Prerequisite: A.B.Ch. 437. Fall semester, odd years. *Mr. Guerrant*
506. VITAMIN ASSAY METHODS (2) Lectures, conferences, and demonstrations dealing with approved methods of vitamin assay including demonstrations of typical vitamin deficiency syndromes in the rat. Prerequisite: A.B.Ch. 505. Spring semester, even years. *Mr. Guerrant*
- 507a. SEMINAR IN PHYSIOLOGICAL CHEMISTRY AND NUTRITION (1 per semester) *Messrs. Guerrant, Boucher, and Pritham*
- 507b. SEMINAR IN FOODS AND ANALYTICAL CHEMISTRY (1 per semester) Fall semester. *Messrs. Triebold and Shigley*
- 507c. SEMINAR IN PLANT, ENZYME, AND INSECTICIDE CHEMISTRY (1 per semester) Spring semester. *Messrs. Frear, Benson, Mallette, and Clagett*
508. BIOCHEMICAL LITERATURE (1-3) Assigned readings, reports, and conferences on selected topics in biochemistry. Prerequisite: A.B.Ch. 437.
510. PROTEINS, AMINO ACIDS, AND PEPTIDES (2) Organic, physical, and biological chemistry of the naturally occurring compounds of this group. Prerequisites: A.B.Ch. 425, 437. Fall semester. *Mr. Mallette*



## AGRICULTURAL AND BIOLOGICAL CHEMISTRY

511. CARBOHYDRATES (2) Chemical constitution and properties of carbohydrates; their metabolism in plant and animal organisms. Prerequisite: A.B.Ch. 437. Spring semester. *Mr. Benson*
512. LIPIDES (2) Investigations on biochemistry of fats and related substances. Spring semester. *Mr. Shigley*
515. BIOMETRY (2) Application of statistical methods to research problems in biochemistry and biology. Prerequisite: Ag. 400. Spring semester, odd years.
516. CHEMISTRY OF THE PESTICIDES (2) Lectures and assigned readings on the chemistry of insecticides, fungicides, herbicides, rodenticides, and related materials. Prerequisite: Chem. 31 or A.B.Ch. 437. Fall semester, even years. *Mr. Frear*
517. ENDOCRINE SECRETIONS (2) Chemistry of hormones and their physiological significance. Prerequisite: A.B.Ch. 437. Spring semester, even years. *Mr. Pritham*
518. MINERAL METABOLISM (2) Utilization and function of mineral elements in animal nutrition. Prerequisite: A.B.Ch. 437. Spring semester, odd years. *Mr. Boucher*
519. INTERMEDIARY METABOLISM (3) Processes involved in the utilization of metabolites in plants and animals. Prerequisite: A.B.Ch. 402. *Mr. Mallette*
520. BIOCHEMICAL METHODS (3) Lectures and advanced laboratory on current techniques pertaining particularly to research on proteins and enzymes. Prerequisite or concurrent: A.B.Ch. 501, 510. *Messrs. Clagett and Mallette*
521. BIOCHEMICAL METHODS (3) Lectures and advanced laboratory on current techniques pertaining particularly to research on lipides and carbohydrates. Prerequisite or concurrent: A.B.Ch. 511, 512. *Messrs. Benson and Shigley*

## AGRICULTURAL ECONOMICS

MACKLIN E. JOHN

*Head of the Department of Agricultural Economics and Rural Sociology*  
1 Weaver Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Baker, Barr, Becker, Brandow, Hutton, Lee, Pierce, and Southworth; Associate Professors Butz, Frey, McAlexander, Pasto, and Trotter.

The entering student in the master's program should have as prerequisites 3 credits in agricultural economics, 3 credits in economics, and 3 additional credits in either agricultural economics or economics. If a student lacks some of the prerequisites, he may take them without graduate credit during the early part of his master's program.

## AGRICULTURAL ECONOMICS

### AGRICULTURAL ECONOMICS (AG EC)

407. ADVANCED FARM MANAGEMENT (3)  
420. AGRICULTURAL PRICES (3) *Mr. Brandow*  
421. LAND ECONOMICS (3) *Mr. Frey*  
426. (A.H. 426). LIVESTOCK MARKETING (3) *Mr. Trotter*
500. SEMINAR IN AGRICULTURAL ECONOMICS (1-6) Review of current literature and problems.
503. RESEARCH METHODS IN FARM MANAGEMENT (1-3) Evaluation of research procedures, methods, results, and needs in the field; emphasis on their application to specific research problems. Prerequisites: Ag.Ec. 6, Econ. 14.
504. AGRICULTURAL PRICE AND INCOME POLICY (3) Analysis of farm prices, income consequences for producers and consumers, and effects on resource use; evaluation of policy, considerations in policy making. Prerequisites: Ag.Ec. 420, Econ. 405. *Mr. Brandow*
505. ADVANCED AGRICULTURAL STATISTICS (3) Multiple correlation, curve fitting, analysis of variance, selection of samples, and other techniques applicable to the rural social sciences. Prerequisite: 3 credits in statistics. *Mr. Bennett*
506. ECONOMIC PROBLEMS IN MARKETING SPECIFIC AGRICULTURAL PRODUCTS (3) Profit maximization; psychological and sociological aspects of selling; engineering aspects of cost reduction; techniques in developing information for managerial decisions.
507. SEMINAR IN FARM MANAGEMENT (1-6) Special problems relating to organization and operation of the farm business. Prerequisites: Ag.Ec. 6, Econ. 14.
510. ADVANCED FARM FINANCE (1-3) Problems and policies in agricultural credit, insurance, and farm financial management. *Mr. Hutton*
515. ECONOMIC PROBLEMS IN THE MARKETING OF DAIRY PRODUCTS (3) Economic problems as they are encountered in the process of marketing; particular attention to governmental regulation in pricing and marketing. *Mr. Pierce*
517. PROBLEMS AND POLICIES OF FARMER CO-OPERATIVES (3) Specific types of co-operative organizations, their problems, policies, and progress; relationships existing among co-operatives, between co-operatives and other business organizations, and between co-operatives and the public. Prerequisite: Ag.Ec. 17. *Mr. Becker*
520. FARM PRICE ANALYSIS (3) Econometric analysis of prices, production, and utilization of farm products; review of research in this field. Prerequisites: Ag.Ec. 420, 505; Econ. 405. *Mr. Brandow*
522. ADVANCED FARM APPRAISAL (3) Land value theory; methods of land valuation; field practice in farm appraisal. *Mr. Frey*
525. RESEARCH METHODS IN RURAL SOCIAL SCIENCES (2) Scientific method in planning and conducting research. Prerequisite: 9 credits in social sciences. *Mr. John*
526. RESEARCH METHODS IN AGRICULTURAL ECONOMICS (2) Application of economic and statistical principles. *Mr. Baker*

## AGRICULTURAL ECONOMICS

534. AGRICULTURAL PRODUCTION ECONOMICS (3) Economic theory applied to agricultural production problems: resource combination, firm size, uncertainty and expectations, aggregate aspects of production, technological change.  
*Mr. McAlexander*
535. SEMINAR IN AGRICULTURAL MARKETING (2) *Mr. Southworth*
536. SEMINAR IN DAIRY ECONOMICS (1 per semester)  
*Messrs. Pierce and Butz*

## AGRICULTURAL EDUCATION

DAVID R. McCLAY, *Head of the Department*  
101 Agricultural Education Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors McClay and Stevens; Assistant Professor Hoover.

The requirements for admission to graduate work in agricultural education are 18 semester hours in professional education courses including educational psychology and practice teaching in vocational agriculture, or certification to teach vocational agriculture. Students who lack any part of these requirements may be admitted but are required to fulfill deficiencies without degree credit.

Minors may be taken in any of the areas of agricultural technology, or, for Master of Science and Doctor of Philosophy degree candidates, in one of the other fields of education, such as educational administration or higher education.

### AGRICULTURAL EDUCATION (AG ED)

- 417v. RURAL EDUCATION SURVEY (2) *Mr. Hoover*
- 418v. SURVEY OF VOCATIONAL EDUCATION IN AGRICULTURE (1-3) *Mr. Hoover*
- 420v. ADVANCED VISUAL AND OTHER SENSORY AIDS IN TEACHING AGRICULTURE (1-6) *Mr. Anthony*
- 422v. SUPERVISION OF VOCATIONAL EDUCATION IN AGRICULTURE (1-3) *Mr. Anthony*
- 434v. AGRICULTURAL DEVELOPMENTS (1-6) *Mr. Hoover*
- 501v. HISTORY OF AGRICULTURAL EDUCATION (1-3) Development of training for agricultural vocations; emphasis upon introduction of agricultural instruction into the high school program. *Mr. Hoover*
- 502v. TEACHING VOCATIONAL AGRICULTURE (1-3) Organization of instruction with respect to vocational objectives, methods of presentation, supervision of practice, pupil evaluation of goals, and follow-up. *Mr. Stevens*
- 503v. RESEARCH IN AGRICULTURAL EDUCATION (1-6 per semester) Individual study problems in various phases of agricultural education, such as evaluation of teaching, teaching procedures, and teacher preparation. *Mr. Stevens*
- 504v. AGRICULTURAL EDUCATION SEMINAR (1 per semester)  
*Mr. McClay and Staff*



## AGRICULTURAL EDUCATION

- 506v. PROBLEMS IN COUNTY VOCATIONAL SUPERVISION (1-3) Needs of county supervisors and vocational directors; co-operation with county superintendents, supervisory duties, plans of work, community meetings and organizations.  
*Mr. Hoover*
- 508v. STATE AND COUNTY ADMINISTRATION AND SUPERVISION OF AGRICULTURAL EDUCATION (1-3) Organization and administration of state, county, township, and district systems of agricultural education; state and federal legislation.  
*Mr. McClay*
- 509v. TEACHER TRAINING IN AGRICULTURAL EDUCATION (1-6) Construction of college curriculums, courses of study, and organization of college departments for training agricultural teachers.  
*Mr. McClay*
- 520v. SCIENTIFIC METHOD IN THE STUDY OF AGRICULTURAL EDUCATION (1-4) Methods of procedure in investigation and experimentation in education, accompanied by a critical examination of studies made in agricultural education.  
*Mr. Stevens*
- 521v. SCIENTIFIC METHOD IN THE STUDY OF AGRICULTURAL EDUCATION (1-4) Continuation of Ag.Ed. 520v; emphasis upon statistical techniques for students' individual problems.  
*Mr. Stevens*
- 522v. FIELD STUDIES IN AGRICULTURAL EDUCATION (1-4) Organization and administration of agricultural education in its local bearings; field laboratory surveys of local school conditions.  
*Mr. McClay and Staff*
- 523v. FIELD STUDIES IN AGRICULTURAL EDUCATION (1-4)  
*Mr. McClay and Staff*
- 524v. ANNUAL PLAN OF WORK (1-3) Detailed study of the agricultural education needs of each student's community and outlining annual plans of work.  
*Mr. Hoover*
- 530v. AGRICULTURAL COLLEGE TEACHING (3) Selection and organization of subject matter for specific courses, methods of learning, teaching devices, technique of teaching, and measurements of results of teaching.  
*Mr. McClay*

## AGRICULTURAL ENGINEERING

FRANK W. PEIKERT, *Head of the Department*  
204 Agricultural Engineering Building

*Degree Conferred:* M.S.

*Graduate Faculty:* Professor Peikert; Associate Professors Bartlett and Walton.

Specialization is offered in farm power and machinery, electric power and processing, soil and water conservation engineering, and farm structures.

Prerequisite to major work is the completion of an undergraduate engineering curriculum from a recognized department.

### AGRICULTURAL ENGINEERING (AG E)

400. AGRICULTURAL ENGINEERING PROBLEMS (1-7)
401. FARM MECHANICS FOR TEACHERS OF VOCATIONAL AGRICULTURE (1½-9)  
*Unit A. Farm Utilities (1½)*

## AGRICULTURAL ENGINEERING

*Unit B. Farm Mechanics (1½)*

*Unit C. Farm Engines (1½)*

*Unit D. Farm Machinery (1½)*

*Unit E. Farm Buildings (1½)*

*Unit F. Soil and Water Structures (1½)*

402. FUNCTIONAL DESIGN OF FARM STRUCTURES (3)

405. ADVANCED FARM ELECTRIFICATION (3)

406. ADVANCED DAIRY ENGINEERING (3)

500. ADVANCED ELECTRO-AGRICULTURE (1-6) Investigations in the application of electrical energy to processing, storing, and handling agricultural products. Seminar, written reports.

501. ADVANCED FARM MACHINERY (1-6) Application of agricultural engineering principles to design and operation of farm machinery. Prerequisite: Ag.E. 110.

502. FARM STRUCTURES PROBLEMS (1-6) Analysis of farm structures design problems.

507. PROBLEMS IN SOIL WATER ENGINEERING (1-6) Analysis of engineering problems relating to irrigation, drainage, or erosion control.

508. ADVANCED PROBLEMS IN FARM MECHANICS (1-15) Problems in farm shop practice and agricultural engineering related to the farm mechanics program of vocational education in agriculture. Prerequisites: Ag.E. 8, 14; or teaching experience in farm mechanics.

509. RESEARCH IN AGRICULTURAL ENGINEERING (1-4)

520. AGRICULTURAL ENGINEERING SEMINAR (1-3) Reports on research and special topics.

## AGRONOMY

HOWARD B. SPRAGUE, *Head of the Department*  
118 Tyson Building

*Degrees Conferred:* Ph.D., M.S., M.Agr.

*Graduate Faculty:* Professors Carnahan, Fortmann, Higbee, Hunter, Jeffries, Kardos, Matelski, Raleigh, Richer, H. B. Sprague, V. G. Sprague, and Washko; Associate Professors Chandler, Pfeifer, and Thomas; Assistant Professors Cleveland, Duich, Marriott, Marshall, Ragland, and Starling.

Areas of specialization include soil chemistry; soil conservation; soil classification; soil fertility; soil mineralogy; soil physics; the breeding of corn, small grains, and forage plants; forage management; turf management; potato culture; tobacco culture; weed control; and ecology of crops and pastures. Facilities are available for X-ray diffraction, infrared and petrographic investigations of soils.

Prerequisites for major work in agronomy vary with the area of specialization, but basic courses in chemistry, mathematics, physics, and biological sciences are required. Students who lack some of the course prerequisites may be admitted but are required to take the prerequisite courses without degree credit.

AGRONOMY (AGRO)

411. BREEDING OF FIELD CROPS (3) *Mr. Cleveland*
416. SOIL CLASSIFICATION (5) *Mr. Higbee*
417. FOREST SOILS (3) *Mr. Matelski*
419. SOIL PROPERTIES (5) *Mr. Ragland*
422. SOIL CONSERVATION (3) *Mr. Kardos*
423. PASTURE AND GRASSLAND MANAGEMENT (3) *Mr. Washko*
424. FERTILIZER TECHNOLOGY (3) *Mr. Marriott*
425. PRINCIPLES OF FIELD CROP PRODUCTION (3)
490. AGRONOMIC PRACTICES (1-6) *Mr. Washko and Staff*
501. ADVANCED SOIL FERTILITY (4) Interpretation of fertility experiments and diagnosis of soil-plant relationships through field appraisal, analysis, and plant symptoms. Prerequisites: Agro. 31, Bot. 406. Spring semester, odd years. *Mr. Hunter*
503. AGRONOMY SEMINAR (1) Weekly meeting where papers and discussions will be presented by students and staff members. *Mr. H. B. Sprague*
506. SOIL CHEMISTRY (4) Analyses of important chemical and biochemical reactions occurring in soils, conditions which control these reactions and their importance in soil genesis and plant growth; laboratory work in the more typical and significant analytical procedures; lectures, review of current literature, and practicum. Prerequisites: Agro. 419; A.B.Ch. 417 or Chem. 20. Spring semester, even years. *Mr. Ragland*
507. SOIL PHYSICS (4) Physical properties of the soil; factors affecting them; their measurements, evaluation, and influence in determination of soil productivity. Prerequisites: Agro. 419, Phys. 215, A.B.Ch. 425. Fall semester, even years. *Mr. Kardos*
509. GENETICS OF CROP PLANTS (3) Inheritance in crop plants with particular reference to factor interaction, genetic aspects of linkage and crossing-over, quantitative inheritance, and heterosis. Prerequisite: Bot. 422. Fall semester, even years. *Mr. Cleveland*
510. THE APPLICATION OF CYTOGENETICS TO PLANT BREEDING (3) Cytogenetics, including chromosome structure and behavior, chromosome alterations, polyploidy, interspecific hybridization and their applications to plant breeding. Prerequisite: Bot. 422. Fall semester, odd years. *Mr. Cleveland*
512. FIELD PLOT TECHNIQUE (4) Ramifications of analysis of variance techniques; combining and analyzing data from several experiments; selection of valid error terms. Prerequisite: Math. 8 or Ag. 400. Fall semester.
516. HUMUS (2) Origin and chemical nature of soil organic matter, its importance in soil processes, and its decomposition. Prerequisites: Agro. 31, 419. Fall semester, odd years. *Mr. Richer*
517. FARM CROPS ECOLOGY (2) Ecological factors influencing distribution and production of field crops. Prerequisites: Math. 8, Bot. 406. Fall semester, even years.
518. GROWTH AND MANAGEMENT OF FORAGE CROPS (3) Factors affecting growth and development of forage crops with particular reference to effects of environment, defoliation, and management practices. Prerequisites: Agro. 423, Bot. 406. Spring semester, odd years.



## AGRONOMY

519. THE NATURE OF SOIL MINERALS (3) Modern methods for identification of the constituent minerals of soils and their relation to soil classification and agricultural practices. Prerequisites: Agro. 1, Chem. 2, Geol. 31. Spring semester, even years. *Mr. Jeffries*
520. SPECIAL SOILS PROBLEMS (1-6 per semester) Provides basic or practical training in the soils sciences by means of library, field, and laboratory assignments.
545. THE APPLICATION OF STATISTICS TO FIELD EXPERIMENTS (4) Use of advanced experimental designs in planning, analyzing, and interpreting experiments; includes lattice designs, factorials, confounding, simple and multiple covariance techniques. Prerequisite: Agro. 512. Spring semester.
550. SPECIAL CROPS PROBLEMS (1-6 per semester) Provides basic or practical training in the crops sciences by means of library, field, and laboratory assignments.
582. SEMINAR IN THE BREEDING AND GENETICS OF FARM CROPS (1-8 per semester)
583. LABORATORY METHODS IN AGRONOMIC RESEARCH (3) Prerequisite: Agro. 512. Summer only.

## ANIMAL HUSBANDRY

RUSSELL C. MILLER, *Head of the Department*  
203 Armsby Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Bortree, Henning, and Miller; Assistant Professor Gobble.

A student may specialize in animal production, animal breeding, and meats. The prerequisite for major graduate work in animal husbandry is the completion of an undergraduate curriculum in animal husbandry or a related animal science area. Students who lack some of the course prerequisites may be admitted but are required to take the prerequisite courses without degree credit.

### ANIMAL HUSBANDRY (A H)

421. ADVANCED MEAT STUDIES (3)  
423. ADVANCED STOCK JUDGING (2)  
424. ANIMAL HUSBANDRY SEMINAR (1)  
426. (Ag.Ec. 426). LIVESTOCK MARKETING (3)  
431. ADVANCED MEAT JUDGING (2)
500. SEMINAR IN ANIMAL HUSBANDRY (1-6)
501. PEDIGREE STUDY (1-6) Research work in breed study history, and analytical study of breed pedigrees, and a complete survey of the herd, flock, or stud book.

## ANIMAL HUSBANDRY

502. RESEARCH IN MEATS (1-6 per semester) Investigation of methods for handling, cutting, processing, freezing, and curing meat and meat products. Prerequisite: A.H. 421.
503. LIVESTOCK MANAGEMENT (3) Handling of purebred herds and flocks; relation of livestock breeders to the public and methods of developing purebred herds and flocks through careful breeding.
505. ADVANCED ANIMAL BREEDING (1-5) Special problems in animal genetics as applied to breeding and improvement of horses, cattle, sheep, and swine. Prerequisites: A.H. 22, Bot. 22.

## ANIMAL NUTRITION

RAYMOND W. SWIFT, *Head of the Department*  
21 Armsby Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Bratzler and Swift; Associate Professor Barron.

For admission a student must have had A.Ntr. 401 and 402 or their equivalent and must have met the requirements for graduate work in agricultural and biological chemistry. Specialized training is offered in the area of energy metabolism. Candidates for this major select courses from a number of related fields.

### ANIMAL NUTRITION (A NTR)

401. PHYSIOLOGY OF NUTRITION (3)  
402. PHYSIOLOGY OF NUTRITION (3)

*Mr. Barron*  
*Mr. Barron*

## ARCHITECTURE and ARCHITECTURAL ENGINEERING

MILTON S. OSBORNE, *Head of the Department of Architecture*  
302 Sackett Building

*Degree Conferred:* M.S.

*Graduate Faculty:* Professors Dickson, Hajjar, Hallock, Osborne, and Richardson; Associate Professors Galbraith and Reis; Assistant Professor Albright.

To enter graduate study in the field of architecture, a degree of Bachelor of Architecture, Bachelor of Science in Architecture, or Bachelor of Fine Arts in a five-year curriculum in architecture is required.

To enter graduate study in the field of architectural engineering, a degree of Bachelor of Architectural Engineering or Bachelor of Science in Architectural Engineering in a five-year curriculum is required.

### ARCHITECTURE (ARCH)

411. ADVANCED ARCHITECTURAL DESIGN (8)  
412. ADVANCED ARCHITECTURAL DESIGN AND THESIS (8)  
421. (A.A.H. 421). CONTEMPORARY ARCHITECTURE (3)

## ARCHITECTURE

501. ARCHITECTURAL DESIGN (4-8) Problems in advanced planning and design, including study of group composition. Practicum and seminar.  
*Mr. Osborne and Staff*
502. ARCHITECTURAL RESEARCH (2-12) Prosecution of assigned problems under the guidance of an instructor.  
*Mr. Osborne and Staff*
503. ARCHITECTURAL HISTORY RESEARCH (3-12) Original research in architectural history. Seminar and written reports.  
*Mr. Dickson and Staff*

## ARCHITECTURAL ENGINEERING (A E)

401. ARCHITECTURAL ENGINEERING (3)
402. ARCHITECTURAL ENGINEERING (4)
403. ARCHITECTURAL ENGINEERING (3)
- \*430. ARCHITECTURAL ENGINEERING (3)
431. ARCHITECTURAL ENGINEERING (3)
432. ARCHITECTURAL ENGINEERING (4)
- \*433. ARCHITECTURAL ENGINEERING THESIS (2)
- †434. ARCHITECTURAL ENGINEERING THESIS (5)
451. FUNDAMENTALS OF NUCLEAR DEFENSE PLANNING AND DESIGN (3)
502. ARCHITECTURAL ENGINEERING (3-8) Advanced structural design in steel and reinforced concrete. Lectures and class criticism. Practicum and seminar.  
*Mr. Richardson and Staff*
503. ARCHITECTURAL ENGINEERING (4-8) Continuation of A.E. 502 in which problems of wind bracing in tall buildings, rigid frames, and heavy-framed constructions are studied. Practicum and seminar. *Mr. Richardson and Staff*
504. ARCHITECTURAL ENGINEERING (4-8) Statically indeterminate stresses in steel and reinforced concrete buildings; area moment, slope deflection, and moment distribution methods. Recitation and seminar. *Mr. Richardson and Staff*
551. ADVANCED NUCLEAR DEFENSE PLANNING AND DESIGN I (3) Weapons effects data; dynamic strength of materials and structural elements; dynamic design; architectural, structural, electrical, and mechanical requirements for shelters. Prerequisites: A.E. 4, 5, 451; E.Mch. 12.
552. ADVANCED NUCLEAR DEFENSE PLANNING AND DESIGN II (3) Blast-resistant design of framed structures, shear wall structures, arches, domes, and underground structures; radiation shielding characteristics of building materials. Prerequisites: A.E. 421, 422, 551; Phys. 237.
553. SELECTED PROBLEMS IN NUCLEAR DEFENSE RESEARCH (1-6) Prerequisite or concurrent: A.E. 451.

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\*Effective fall of 1964. Until that date students should register for A.E. 420 and 423 instead of A.E. 430 and 433.

†Effective spring of 1965. Until that date students should register for A.E. 424 instead of A.E. 434.



## ART

BEN EUWEMA, *Acting Director, School of the Arts*  
105 Sparks Building

*Degree Conferred:* M.A.

*Graduate Faculty:* Professors Hyslop and Zoller; Associate Professors Enggass, Weisman, and Zoretich; Mr. Shobaken.

Students may specialize in studio work or in the history of art and architecture. For admission at least 18 credits of undergraduate work in art are required. The graduate program is contingent upon the student's undergraduate preparation. If an inadequacy exists, the student will be required to make up the deficiency without degree credit.

## ART (ART)

- 400. ADVANCED OIL PAINTING (3-12)
- 410. WATER-COLOR PAINTING: LANDSCAPE, STILL LIFE, AND FIGURE (3-9)
- 420. APPLIED DESIGN (3-9)
- 431. SCULPTURE (2-6)
- 440. PRINTMAKING (2-6)
- 490. LIFE DRAWING (3)
- 500. ART RESEARCH (2-6) Prosecution of assigned problems under the guidance of an instructor.
- 510. ADVANCED PAINTING (2-12)
- 531. ADVANCED SCULPTURE (2-12)
- 540. ADVANCED PRINTMAKING (2-12)

## ART AND ARCHITECTURAL HISTORY (A A H)

- 413. PROBLEMS IN ART HISTORY (3-6 per semester)
- 421. (Arch. 421). CONTEMPORARY ARCHITECTURE (3)
- 448. HISTORY OF PRINTS AND DRAWINGS (3)
- 502. SEMINAR IN MEDIEVAL ART (3-6) Original research into problems dealing with the art of the middle ages.
- 503. ART HISTORY RESEARCH (3-6) Original investigation in art history, to be pursued independently or concurrently with course work in particular fields.
- 505. SEMINAR IN BAROQUE ART (3-6) Investigations in the area of Baroque art centering around major masters and monuments.
- 506. SEMINAR IN MODERN ART (3-6) Lectures, readings, reports, and discussions in the field of modern art.
- 508. SEMINAR IN AMERICAN ART (3-6) Studies in the field of American art involving original research.

## ART—MUSIC—THEATRE (A M T)

- 400. CONTEMPORARY FORMS IN ART, MUSIC, THEATRE I (3)
- 401. CONTEMPORARY FORMS IN ART, MUSIC, THEATRE II (3)

## ART EDUCATION

VIKTOR LOWENFELD, *Head of the Department*  
207B Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professor Lowenfeld; Associate Professors Beittel, Chomicky, and Mattil; Assistant Professors Pappas and Schinneller.

It is generally expected that students admitted to work toward a master's degree have one year of teaching experience and present the equivalent of an approved four-year art education curriculum. A student may not receive his doctor's degree without having had at least two years of successful teaching experience.

### ART EDUCATION (A ED)

402. PROFESSIONAL ORIENTATION OF THE ART TEACHER (3)  
404. METHODS OF GRAPHICS AND ILLUSTRATIONS (3)  
414. ADVANCED CRAFTS FOR TEACHERS (3-6)  
420. CERAMICS FOR TEACHERS (3)  
434. ART APPRECIATION IN THE EDUCATIONAL PROGRAM (3)  
434b. ART IN THE ELEMENTARY SCHOOL (2-3)  
434c. ART IN THE SECONDARY SCHOOL (3)  
434d. ART SUPERVISION (3)  
486. CURRENT PROBLEMS IN ART EDUCATION (2-3)  
487. MURAL PAINTING IN SCHOOLS (3)  
488. ADVANCED MURAL PAINTING IN SCHOOLS (3)  
489. ART EXPERIENCES WITH CHILDREN (3)
504. ADVANCED METHODS IN GRAPHIC PROCESSES (3) Exploration through laboratory experience of printing method: etching, silk screen, linoleum, or other; applications in teaching.
514. FUNCTIONAL RELATIONSHIPS IN CRAFTS (3) Relationships of material design and purpose in crafts discussed by means of outstanding products of different materials, periods, and cultures. Prerequisite: 6 credits in crafts or 3 in design and 3 in advanced crafts. *Messrs. Mattil and Pappas*
516. ANALYSIS OF THREE-DIMENSIONAL PROCESSES IN ART (3) Three-dimensional processes analyzed with regard to kinetic, textural, form, and other functions. *Mr. Chomicky*
520. ADVANCED CERAMIC ART (3) Intensified exploration of throwing, glazing, and firing processes as related to aesthetic considerations in contemporary art forms and past cultures. Prerequisite: A.Ed. 420. *Messrs. Beittel and Pappas*
534. CREATIVE ART ACTIVITY FOR THE HANDICAPPED (3) Specific methods for development of creative art activity with the physically, mentally, emotionally, and socially handicapped; adjustive effect upon them. Prerequisite: 6 credits in art education or 6 in special education or 6 in psychology. *Mr. Lowenfeld*
586. RESEARCH IN ART EDUCATION (3-9) Current experiments in art education; required of students working for a master's degree in art education. *Mr. Beittel*
588. HISTORY OF ART EDUCATION (3) Historical development of philosophies in art education in the United States and abroad. *Mr. Lowenfeld*

## BACTERIOLOGY

ROBERT W. STONE, *Head of the Department*  
204 Patterson Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Bratzler, Cone, Dunne, Ludwig, Reid, and Stone; Associate Professors Gentry, Heist, Lindstrom, and Zimmerman; Assistant Professors Casida and Kinsloe.

Specialized areas of study include bacterial physiology, soil microbiology, food and industrial microbiology, immunology, and virology. There is opportunity for research in animal disease in co-operation with the Department of Veterinary Science.

Prerequisites for admission are 20 semester hours of chemistry including quantitative analysis and organic chemistry, and 20 semester hours of biological science including 8 hours of microbiology. It is possible to substitute additional chemistry credits for part of the biology requirement.

## BACTERIOLOGY (BACT)

- 401. GENERAL MICROBIOLOGY (4)
- 407. BACTERIOLOGY PROBLEMS (2-9)
- 410. IMMUNOLOGY AND SEROLOGY (4)
- 411. BACTERIOLOGICAL SURVEY (1)
- 412. ADVANCED BACTERIOLOGY (4)
- 413. SOIL MICROBIOLOGY (3)
- 414. FOOD MICROBIOLOGY (4)
- 416. INDUSTRIAL MICROBIOLOGY (4)
  
- 506. RESEARCH (1-15 per semester) Special problems in microbiology.
- 507. SEMINAR (1 per semester) Reports on current fields of research.
- 508. PHYSIOLOGY OF BACTERIA (2) Composition, nutrition, and growth of microorganisms; influence of physical and chemical environment on metabolism.
- 508a. LABORATORY IN PHYSIOLOGY OF BACTERIA (2) Laboratory work to accompany the lectures given in Bact. 508.
- 509. FERMENTATION (2) Chemical activities of microorganisms; mechanisms of fermentative and oxidative metabolism.
- 510. LABORATORY IN FERMENTATION (2) Laboratory procedures and problems in fermentation to accompany Bact. 509.
- 512. BACTERIOLOGICAL TECHNIQUES (1-6) Practice in special laboratory techniques including manometry, tissue culture, and serology.
- 515. (V.Sc. 515). VIROLOGY (2-4) Rickettsial and viral agents parasitizing man, animals, and microorganisms. Prerequisite: Bact. 410.
- 516. BACTERIAL GENETICS (2-4) Mechanisms of variation in microorganisms including mutation, adaption, sexual recombination, transduction, and transforming factors. Prerequisite: 3 credits each in bacteriology and genetics.



## BIOLOGICAL SCIENCE

### BIOLOGICAL SCIENCE

LEON R. KNEEBONE, *Chairman of the Committee on Biological Science*  
117 Buckhout Laboratory

*Degrees Conferred:* D.Ed., M.Ed.

The program in biological science is designed to meet the needs of secondary school science teachers. The academic degrees M.S. and Ph.D. are not offered in biological science but are available in agricultural and biological chemistry, bacteriology, botany, entomology, genetics and breeding, plant pathology, and zoology.

In order to enter a program for a higher degree with a major in biological science, the candidate should present 30 credits in the natural sciences, including at least one year of chemistry, and 18 credits in education, including educational psychology and practice teaching. As many as 6 credits may be made up as undergraduate deficiencies after the candidate is admitted to the Graduate School.

The candidate for the M.Ed. degree must take at least 24 credits in the biological sciences. As many as 9 of these may be taken in the physical sciences and/or mathematics. In addition, at least 6 credits in educational foundations are required.

### BOTANY

J. E. LIVINGSTON  
*Head of the Department of Botany and Plant Pathology*  
206 Buckhout Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Grove, Kribs, Livingston, and Wahl; Associate Professors Fergus, Hill, Kneebone, and Wright; Assistant Professors Fritz, Grun, Hillson, Hovin, and Kovar.

The student majoring in botany may specialize in any one of the branches of this subject, such as plant anatomy, cytology, ecology, genetics, morphology, mycology, physiology, plant pathology, and taxonomy. In order to enter graduate work in this field, a student should present 27 credits of undergraduate work in botany or 21 credits in botany and 6 in biological science. As many as 6 credits may be made up as undergraduate deficiencies after the candidate has been admitted to the Graduate School.

In addition to its excellent facilities for research in various phases of botany, genetics, and plant pathology, the department is equipped with a Gamma Radiation Laboratory for the study of irradiation effects upon plants and other facets of radiation biology.

*See also "Plant Pathology" and "Genetics and Breeding."*

#### BOTANY (BOT)

405. (Zool. 405). GENERAL CYTOLOGY (3)  
406. PLANT PHYSIOLOGY (4)

*Mr. Grun*  
*Mr. Fritz*

407. PLANT ANATOMY (3) *Mr. Kribs*  
 409. PLANT ECOLOGY (3) *Mr. Kovar*  
 414. TAXONOMY OF VASCULAR PLANTS (3) *Mr. Wahl*  
 415. MORPHOLOGY OF THE ALGAE (3) *Mr. Wahl*  
 416. MORPHOLOGY OF THE BRYOPHYTES (2) *Mr. Grove*  
 417. MORPHOLOGY OF THE TRACHEOPHYTA EXCLUSIVE OF ANGIOSPERMS (3) *Mr. Grove*  
 418. BOTANICAL PROBLEMS (1-6)  
 419. MYCOLOGY (3) *Mr. Fergus*  
 420. MORPHOLOGY OF THE ANGIOSPERMS (3) *Mr. Grove*  
 421. BOTANICAL TECHNIQUE (3) *Mr. Grove*  
 422. (Zool. 422). ADVANCED GENETICS (3) *Messrs. Wright and Grun*  
 424. COMMERCIAL TROPICAL WOODS (3) *Mr. Kribs*  
 427. ADVANCED SYSTEMATIC BOTANY (1-6) *Mr. Wahl*  
 433. (Zool. 433). GENETICS, EUGENICS, AND EVOLUTION FOR TEACHERS (3) *Messrs. Wright and Grun*  
 500. PLANT PHYSIOLOGY SEMINAR (1 per semester) Selected topics from recent literature; staff and student reports on current research. Spring semester, even years. *Mr. Fritz*  
 501. THE PHYSIOLOGY OF THE FUNGI (3) Chemical composition, metabolism, toxic and stimulating agencies, spore germination, growth and irritability of the fungi. Prerequisites: Bot. 406, 419, and preferably Chem. 32. Fall semester, even years. *Mr. Fergus*  
 505. (Zool. 505). CYTOLOGY AND CYTOGENETICS (3) Chromosome mechanism of heredity; relationship between plant and animal evolution and breeding and changes in chromosomes; cytological and cytochemical techniques. Prerequisite: Bot. (Zool.) 405 or 422. Fall semester, even years. *Mr. Grun*  
 506. COMPARATIVE ANATOMY OF VASCULAR PLANTS (3) Structure of the Tracheophyta from a phylogenetic standpoint. Prerequisite: Bot. 407. Spring semester, even years. *Mr. Kribs*  
 \*511. PHYSIOLOGY OF PLANT GROWTH AND DEVELOPMENT (2-4) Prerequisite: Bot. 406. Spring semester, every 2 or 3 years. *Mr. Fritz*  
 \*512. PHYSIOLOGY OF PLANT METABOLISM (2-4) Prerequisite: Bot. 406. Fall semester, even years. *Mr. Fritz*  
 \*513. WATER AND MINERAL RELATIONS OF PLANTS (2-4) Absorption of water and minerals; transport of materials within the plant; physiology of transpiration. Prerequisite: Bot. 406. Fall semester, odd years. *Mr. Fritz*  
 518. BOTANICAL PROBLEMS (1-15 per semester)  
 521. MOLDS, YEASTS, AND ACTINOMYCETES (3) Morphology and taxonomy of fungi important in microbiology; identification and techniques of study. Spring semester, even years. *Mr. Fergus*  
 522. MYXOMYCETES, PHYCOMYCETES, AND ASCOMYCETES (4) Morphology, taxonomy, phylogeny, and life histories; identification and field work. Prerequisite: Bot. 419. Fall semester, odd years. *Mr. Fergus*

\*Credits to be arranged, 2 or 4.

## BOTANY

523. BASIDIOMYCETES AND FUNGI IMPERFECTI (4) Morphology, taxonomy, phylogeny, and life histories. Prerequisite: Bot. 419. Spring semester, even years. *Mr. Fergus*
524. (Zool. 524). SEMINAR IN GENETICS (1 per semester) *Messrs. Wright and Grun*
- 525a,b. STRUCTURE OF ECONOMIC PLANTS (3 each) Developmental and reproductive features of (a) field and vegetable crops, (b) fruit crops. Bot. 525a, spring semester, odd years; 525b, spring semester, even years. *Mr. Grove*
526. PHOTOMICROGRAPHY OF PLANT TISSUES (2) Prerequisite: Bot. 421 or Zool. 31 or W.U. 37. Spring semester, even years. *Mr. Kribs*
- 527a,b. PLANT BIOLOGY FOR TEACHERS (3 each) (a) Structure and physiology; (b) reproduction processes, development and relationships of plant groups. Methods of obtaining materials and setting up experiments. Designed for teachers and prospective teachers. Prerequisite: general biology or general botany courses. Summer only; a and b given in alternate years.
528. (Zool. 528). POPULATION GENETICS (3) Factors affecting gene frequency, genotype frequency, genotype-environmental interaction, and genetic relationship in natural and artificial populations. Fall semester, odd years.
533. (Zool. 533). PROBLEMS IN GENETICS (2-6) Problems to suit needs of individual students; conferences and laboratory work. Prerequisite: Bot. (Zool.) 422. *Messrs. Wright and Grun*
537. (Sec.Ed. 537, Zool. 537). WORKSHOP IN THE BIOLOGICAL SCIENCES (3) Projects designed for teachers of biology in the secondary schools. Summer only.

## BUSINESS ADMINISTRATION

ROBERT D. PASHEK

*In Charge of Graduate Programs in Business Administration*  
128 Boucke Building

*Degrees Conferred:* Ph.D., M.S., M.B.A.

*Graduate Faculty:* Professors Bradley, Cook, Hench, McKinley, Nelson, Saylor, Stout, Strong, Tanner, Waters, and Wherry; Associate Professors Babione, Clewett, Colwell, Kautz, Kniffin, Mares, Pashek, and Richards; Assistant Professor Phalan.

Specialization is possible in the following fields: accounting, banking and finance, insurance and real estate, management, marketing, and transportation and trade.

The M.B.A. program is designed for those desiring professional training in business administration, regardless of their undergraduate background. An applicant with little or no training in business administration may be admitted to the M.B.A. program and may schedule necessary preparatory courses, without gradu-



## BUSINESS ADMINISTRATION

ate credit, while pursuing the graduate program. Three credits are required as preparatory courses in each of the following: accounting, business law, business statistics, economics, finance, management, and marketing.

The M.S. in business administration is designed for those interested primarily in research or who plan to work toward the Ph.D. with a major in business administration.

For admission to the programs leading to the M.S. and Ph.D. degrees with a major in business administration, a minimum of 18 acceptable undergraduate credits in the fields of accounting, commerce, economics, and business statistics—including at least 6 in economics and 3 in business statistics—is required. An applicant may be admitted with slight specific deficiencies which must be made up without degree credit.

An applicant with little or no undergraduate training in the field of business administration may enroll as an undergraduate student in business administration for one or more semesters and then be admitted to the Graduate School if his record is satisfactory.

Applicants for the various graduate programs in business administration are required to take the Admission Test for Graduate Study in Business given by the Educational Testing Service and used by leading graduate business schools throughout the country to supplement other criteria for admission. Candidates are strongly urged to take the test at the earliest possible date. The test will be given at numerous locations in most states and foreign countries in November, February, April, and July. For dates and locations see the *Bulletin of Information*, Admission Test for Graduate Study in Business, published by the Educational Testing Service, 20 Nassau Street, Princeton, New Jersey. Applicants should read the *Bulletin* carefully. All arrangements for taking the test must be made directly with the Educational Testing Service.

### ACCOUNTING (ACCTG)

- 401. ADVANCED ACCOUNTING (3)
- 403. ADVANCED AUDITING (3-9)
- 404. COST AND BUDGETARY CONTROL (3)
- 406. ADVANCED FEDERAL TAX ACCOUNTING (3)
- 407. C.P.A. PROBLEMS (3)
- 408. GOVERNMENTAL ACCOUNTING (3)
- 409. MACHINE AND ELECTRONIC ACCOUNTING METHODS (3)
- 500. ACCOUNTING SEMINAR (3-6)
- 502. MANAGERIAL ACCOUNTING (3-6) Accounting techniques as control devices in business and industry; the use of quantitative data for policy decisions.
- 520. PROBLEMS IN ACCOUNTING (3-6) Planned individual projects involving library, laboratory, or field work.

### COMMERCE (COM)

- 405. ANALYSIS OF FINANCIAL STATEMENTS (3)
- 406. INVESTMENT ANALYSIS (3)
- 408. CASE STUDIES IN BANKING AND FINANCE (3)
- 415. REGULATION OF TRANSPORT CARRIERS (3)

## BUSINESS ADMINISTRATION

- 416. PROBLEMS IN TRADE AND TRANSPORTATION (3)
- 424. MARKETING RESEARCH (3)
- 427. RETAIL BUYING AND MERCHANDISING (3)
- 428. RETAIL ADVERTISING AND SALES PROMOTION (3)
- 430. ADVANCED BUSINESS LAW (3)
- 434. ADVANCED PROPERTY AND CASUALTY INSURANCE (3)
- 435. ESTATE PLANNING (3)
- 436. FUNDAMENTALS OF SALES MANAGEMENT (3)
- 437. CASE STUDIES IN MARKETING (3)
- 438. ADVANCED MARKETING (3)
- 451. URBAN LAND UTILIZATION (3)
- 455. CASES IN PUBLIC RELATIONS (3)
- 474. BUSINESS POLICY FORMULATION AND CONTROL (3)
- 477. ADMINISTRATIVE MANAGEMENT (3)
  
- 500. CASE STUDIES IN BUSINESS ADMINISTRATION (3) Case studies of business and management policy with respect to procurement, production, selling, finance, accounting, relations with government, labor, and the public.
- 501. COMMERCE SEMINAR (3-6) Reports on research in selected fields of commercial activities.
- 502. SEMINAR IN BUSINESS MANAGEMENT (3-6)
- 503. TRANSPORTATION AND PUBLIC UTILITY SEMINAR (3-6)
- 504. PROBLEMS IN COMMERCE (3-6) Planned individual projects involving library, laboratory, or field work.
- 506. SEMINAR IN INVESTMENTS AND CORPORATION FINANCE (3-6)
- 517. INTERNATIONAL BUSINESS PRACTICES (3) Practices of exporters and importers dealing in commodities traded in world markets under competition, monopoly, or governmental control. Prerequisite: Com. 17.
- 523. SEMINAR IN MARKETING (3-6) Research in modern marketing trends.
- 525. CASE STUDIES IN INSURANCE (3-6) Analysis of management's insurance problems, such as the feasibility of self-insurance; proper allocation of insurance premiums and coverage in selected industries, etc. Prerequisites: Com. 25, 33.
- 536. SALES MANAGEMENT SEMINAR (3) Principles of sales planning and administration; co-ordination of selling with advertising, promotion, production, and accounting; use of market research selling costs and budgets.
- 574. BUSINESS RESEARCH (3) A project paper, comparable in quality and scope of work to a graduate thesis, on problems of a company. Prerequisite: 15 credits of 400 and 500 courses in business administration.
- 577. ADMINISTRATIVE INTEGRATION (3) An analysis of co-ordination of the functional areas of business in relation to over-all company objectives. Prerequisite: 15 credits of 400 and 500 courses in business administration.

## BUSINESS EDUCATION

JAMES GEMMELL, *in Charge of Graduate Programs in Business Education*  
208 Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Gemmell and Veon.

Graduate programs provide advanced preparation for secondary school and college teachers of bookkeeping, secretarial, clerical, general business, retailing, and related subjects.

A minimum of 18 acceptable undergraduate credits in education and psychology plus a minimum of 30 credits in business and business education subjects are required for admission.

All candidates specializing in business education are encouraged to acquire a general education in the social sciences, the behavioral sciences, and the humanities.

The following courses in business education are described on page 165 under the heading Secondary Education: Sec.Ed. 456, 459, 460, 461, 462, 463, 464, 466, 467, 468, 511, 575, 576, 577, and 578.

## CERAMIC TECHNOLOGY

G. W. BRINDLEY, *Head of the Department*  
214 Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Brindley, Buessem, and Hummel; Associate Professor Williamson; Assistant Professor Rindone.

The background for admission is a bachelor's degree in ceramics or in one of the related physical sciences. A knowledge of differential and integral calculus is required together with adequate physics and chemistry.

In view of the wide field covered by ceramic technology, the graduate courses may be selected with a bias toward physical ceramics, chemical ceramics, or glass technology. This makes it easily possible for students whose major subject for the bachelor's or master's degree has been either physics or chemistry to take appropriate graduate studies in ceramic technology.

Special facilities exist for research in the areas of clay mineralogy, phase diagram and related studies, ferrite and ferroelectric studies, glass technology, and high temperature reaction kinetics.

### CERAMIC TECHNOLOGY (CER T)

- 401. CERAMIC BODIES AND GLAZES (2)
- 402. PRINCIPLES OF CERAMIC ENGINEERING (3)
- 404. CERAMIC SEMINAR (1)
- 405. CERAMIC RESEARCH AND DESIGN (3)
- 411. PRINCIPLES OF CERAMIC PROCESSES (2)

*Mr. Hummel*  
*Mr. Williamson*  
*Mr. Hummel*

*Mr. Buessem*



## CERAMIC TECHNOLOGY

412. SURFACE CHEMISTRY OF CERAMIC MATERIALS (1) Mr. Weyl  
 415. PRINCIPLES OF GLASS TECHNOLOGY (3) Mr. Rindone  
 420. REFRACTORIES (2)  
 430. ELECTROCERAMICS (1) Mr. Buessem  
 450. CONSTITUTION AND PHYSICAL MEASUREMENTS LABORATORY (1-3)
500. SEMINAR IN CERAMIC TECHNOLOGY (1-2 per semester) Current developments in ceramic technology and related fields. Required of all graduate students in ceramic technology. Mr. Brindley and Staff
501. COLLOIDAL BEHAVIOR OF CLAYS AND MUDS (2-4) Colloidal properties of ceramic clays, glazes, drilling muds, filtering and bleaching clays, and kindred systems. Mr. Williamson
503. USE OF PHASE EQUILIBRIA DATA IN CERAMIC TECHNOLOGY (2-5) Phase equilibria in unary, binary, ternary, and other systems; applications in product development and in understanding behavior of ceramic materials. Mr. Hummel
506. MECHANICAL PROPERTIES OF CERAMIC MATERIALS (2-3) Experimental stress-strain-time relations in elasticity, anelasticity, plasticity, and rupture; theory of strength and control. Mr. Buessem
507. THERMAL PROPERTIES OF CERAMIC MATERIALS (2-3) Heat capacity, heat of fusion, thermal conductivity, and thermal expansion in relation to macroscopic measurements and basic atomic concepts applied to ceramic materials.
508. DIELECTRIC AND MAGNETIC PROPERTIES OF CERAMIC MATERIALS (2-3) Preparation and properties of ceramic semi-conductors, dielectrics, and magnetic materials. Mr. Buessem
510. SEMINAR IN GLASS TECHNOLOGY (1-2 per semester) Current developments in glass technology and related fields. Mr. Rindone
511. CHEMICAL ASPECTS OF THE CONSTITUTION OF GLASS (1-3 per semester) Historical development, properties, and atomistic interpretation of changes of properties with compositions, temperature, and past history. Mr. Weyl
512. PHYSICAL ASPECTS OF THE CONSTITUTION OF GLASS (1-3) Atomic structure of glass, its relation to physical properties; rheology; glass as a liquid. Mr. Brindley
515. SPECIAL PROBLEMS IN CERAMIC TECHNOLOGY (1-6 per semester) Advanced individual study on a problem in ceramics.
516. SELECTED TOPICS IN CERAMIC TECHNOLOGY (1-3 per semester) Intensive group study of special topics.
517. RESEARCH INSTRUMENTS AND EQUIPMENT (2) Applications of fundamental laws and principles in research instruments; care, adjustment, and effective use of instruments and equipment (demonstrations).
530. (Min. 530). STRUCTURE, PROPERTIES, AND OCCURRENCE OF CLAY MINERALS (2-5) Structure analysis and identification of clay minerals; mineral transformation and behavior; occurrence, genesis, and petrography of fine-grained sediments. Messrs. Brindley, Bates, and Griffiths

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in ceramic technology studies are listed under Mineral Sciences in Part II of this bulletin. The subject of color in glasses is treated in Min. 521.

# CHEMICAL ENGINEERING

MERRELL R. FENSKE, *Head of the Department*  
131 Chemical Engineering Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Cannon, Fenske, Quiggle, and Rose; Associate Professors Carnahan, Hersh, Jones, Klaus, McCormick, and Williams; Assistant Professor Lloyd.

Course offerings or research facilities are available in the following areas: phase equilibria, thermodynamics, unit operations, unit processes, nuclear chemical engineering, petroleum technology, rheology, and lubrication. The facilities for instruction and research in chemical engineering and petroleum chemistry include those of the Petroleum Refining Laboratory.

The minimum requirements for admission are 24 semester hours of chemical engineering including stoichiometry, industrial chemistry, unit operations, thermodynamics, plant design, kinetics, or chemical engineering problems; 14 semester hours of engineering including engineering mechanics, electrical engineering, or mechanical engineering basic courses; chemistry through one year of physical chemistry; and mathematics through differential equations.

Thesis research work in petroleum chemistry, for the M.S. and Ph.D. degrees in chemistry, may be done in the Department of Chemical Engineering.

## CHEMICAL ENGINEERING (CH E)

- |                                                                                                                                                                                       |                                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| 402. CHEMICAL ENGINEERING (4)                                                                                                                                                         | <i>Mr. Lloyd</i>                  |
| 403. CHEMICAL ENGINEERING (4)                                                                                                                                                         | <i>Mr. Lloyd</i>                  |
| 404. CHEMICAL PLANT DESIGN (3)                                                                                                                                                        | <i>Messrs. Williams and Engel</i> |
| 405. THERMODYNAMICS FOR CHEMICAL ENGINEERS (3)                                                                                                                                        | <i>Mr. Cannon</i>                 |
| 406. CHEMICAL ENGINEERING PROBLEMS (3)                                                                                                                                                | <i>Messrs. Williams and Engel</i> |
| 420. CRYOGENIC ENGINEERING (3)                                                                                                                                                        | <i>Mr. Fritz</i>                  |
| 422. MOTOR FUELS (2)                                                                                                                                                                  | <i>Mr. Carnahan</i>               |
| 430. NUCLEAR CHEMICAL ENGINEERING (3)                                                                                                                                                 | <i>Mr. Lloyd</i>                  |
| 500. SEMINAR IN CHEMICAL ENGINEERING (1) Required of all graduate students.                                                                                                           |                                   |
| 510. ADVANCED HEAT TRANSFER I (3) Physical and chemical factors controlling the rate of heat transfer under conditions of steady flow.                                                |                                   |
| 511. ADVANCED HEAT TRANSFER II (3) Flow of heat under varying temperature conditions.                                                                                                 |                                   |
| 515. DISTILLATION (3) Commercial distillation, equilibrium diagrams, vapor composition, stills and rectifying and stripping columns.                                                  | <i>Mr. Braun</i>                  |
| 516. ECONOMIC BALANCE (3) Problem work on the design of chemical engineering equipment from the economic standpoint.                                                                  | <i>Mr. Cannon</i>                 |
| 518. CHEMICAL ENGINEERING DESIGN (3) Complicated examples are discussed and worked out. Several different unit operations will be combined for the design of a complete installation. |                                   |

## CHEMICAL ENGINEERING

520. EXTRACTION PROCESSES (3) Equilibrium extraction data and phase contacting and settling related to equipment design. *Mr. Braun*
521. MASS TRANSFER (3-12) Problem course on developments in diffusion, fluid dynamics, phase equilibrium, process kinetics, and control; use of digital and analog computers. *Messrs. Rose and Engel*
524. CHEMICAL ENGINEERING, APPLICATION OF THERMODYNAMICS (3) Elements of thermochemistry and thermodynamics of greatest importance in chemical engineering. *Mr. Cannon*
530. HEAT TRANSFER IN NUCLEAR REACTORS (3) Fluid flow, heat transfer, and design problems in nuclear reactor systems. *Mr. Lloyd*

## CHEMISTRY

W. CONARD FERNELIUS, *Head of the Department*  
212 Whitmore Laboratory

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Aston, Fenske, Fernelius, Fleming, Hutchison, Miller, Noll, Oakwood, Quiggle, Seward, Smith, Taft, and Willard; Associate Professors Ascah, Deno, Dixon, Fritz, Haas, Hayes, Holtzinger, Jones, Jordan, Klaus, Schempff, Skell, Sommer, Wartik, and Zook; Assistant Professors Benson, Bertaut, Currie, Gilbert, Gingerich, Goodman, Lotz, Montjar, Richey, Schmulbach, Shamma, and Steele.

Students may specialize in analytical, inorganic, organic, physical, and petroleum chemistry. The general facilities for instruction and research in the major fields of chemistry are excellent, while the cryogenic, microscopy, petroleum, radiochemical, and spectroscopy laboratories provide unusual research opportunities.

Entering graduate students should have had training which includes at least one year's work in each of the following: general chemistry, analytical chemistry, organic chemistry, physical chemistry, and general physics. Mathematics through integral calculus is required, and a reading knowledge of at least one foreign language, preferably German, is expected.

Prior to scheduling their first semester's program, new students will take examinations in the four areas of analytical, inorganic, organic, and physical chemistry. The information obtained from these tests will assist both the student and his adviser in making up a program best suited to the student's needs. These examinations are normally given just prior to the regular registration period.

## CHEMISTRY (CHEM)

400. CHEMICAL LITERATURE (1) *Mrs. Strauss*
401. SEMINAR (1)
405. NUCLEAR AND RADIOCHEMISTRY (3) Breakage ticket \$5. *Messrs. Currie and Miller*
410. ADVANCED INORGANIC CHEMISTRY (4) Breakage ticket \$5.
413. INORGANIC PREPARATIONS AND LABORATORY METHODS (2-5) Breakage ticket \$5.



## C H E M I S T R Y

420. ADVANCED ANALYTICAL CHEMISTRY (4) Breakage ticket \$10.  
*Messrs. Hayes, Jordan, and Schempf*
426. INSTRUMENTAL METHODS OF ANALYSIS (3-5) Breakage ticket \$10.  
*Messrs. Hayes, Jordan, and Schempf*
435. ORGANIC PREPARATIONS AND LABORATORY METHODS (3-5) Breakage ticket \$10.  
*Mr. Oakwood*
437. QUALITATIVE ORGANIC ANALYSIS (3) Breakage ticket \$5.  
*Messrs. Oakwood and Noll*
440. ADVANCED PHYSICAL CHEMISTRY (3) *Messrs. Hutchison and Seward*
441. ADVANCED PHYSICAL CHEMISTRY (2) *Messrs. Fritz and Taft*
448. COLLOID CHEMISTRY (3) Breakage ticket \$5. *Mr. Benson*
- \*460-461. INTRODUCTORY PHYSICAL CHEMISTRY (3 each)
- \*462. EXPERIMENTAL PHYSICAL CHEMISTRY (1) Breakage ticket \$5.
- \*463. EXPERIMENTAL PHYSICAL CHEMISTRY (1) Breakage ticket \$5.
- \*464-465. PHYSICAL CHEMISTRY (3 each)
470. CHEMICAL MICROSCOPY (3) Breakage ticket \$5. *Miss Willard*
471. SPECIAL TOPICS IN CHEMICAL MICROSCOPY (2-6) Breakage ticket \$5.  
*Miss Willard*
472. QUANTITATIVE ORGANIC MICROANALYSIS (3) Breakage ticket \$5.  
*Mr. Fleming*
474. QUANTITATIVE ORGANIC MICROANALYSIS (3) Breakage ticket \$5.  
*Mr. Fleming*
477. CHEMICAL PHOTOMICROGRAPHY (3) Breakage ticket \$5. *Miss Willard*
489. INTRODUCTION TO CHEMICAL RESEARCH (3-5) Breakage ticket \$10.
- †490. ORGANIC CHEMISTRY (5) Breakage ticket \$5.
- †491. ORGANIC CHEMISTRY (5) Breakage ticket \$10.
- 492a. ADVANCED GENERAL CHEMISTRY FOR TEACHERS (3)
493. SELECTED TOPICS IN CHEMISTRY FOR TEACHERS (3)
494. CHEMICAL DEMONSTRATIONS FOR TEACHERS (3)
500. SEMINAR IN INORGANIC CHEMISTRY (1 per semester)
501. SEMINAR IN PHYSICAL CHEMISTRY (1 per semester)
502. SEMINAR IN ORGANIC CHEMISTRY (1 per semester)
503. SEMINAR IN ANALYTICAL CHEMISTRY (1 per semester)
516. SYSTEMATIC INORGANIC CHEMISTRY (3) Systematic treatment of inorganic chemistry in terms of modern concepts. *Messrs. Fernelius, Wartik, and Haas*
517. CHEMISTRY OF THE LESS FAMILIAR ELEMENTS (3) Continuation of Chem. 516.  
*Messrs. Fernelius, Wartik, and Haas*
518. SPECIAL TOPICS IN INORGANIC CHEMISTRY (3 per semester) Modern developments in specialized fields.
525. ANALYTICAL PROCESSES (3) Separative and determinative processes in analytical chemistry.  
*Messrs. Hayes, Jordan, and Schempf*
526. MODERN INSTRUMENTAL ANALYSIS (3)  
*Messrs. Hayes, Jordan, and Schempf*

\*Graduate credit not allowed for students majoring in chemistry or chemical engineering.

†Candidates for the M.Ed. degree.

## CHEMISTRY

527. SPECIAL TOPICS IN ANALYTICAL CHEMISTRY (2-12)  
*Messrs. Hayes, Jordan, and Schempf*
531. SPECIAL TOPICS IN ORGANIC CHEMISTRY (3-12)
532. ORGANIC NITROGEN COMPOUNDS (3) Chemistry, stereochemistry, and molecular structure of organic compounds containing nitrogen. *Mr. Aston*
534. THEORETICAL ORGANIC CHEMISTRY (3) Modern theories of structure; resonance; interpretation of physical properties; theory of rates; equilibrium properties. *Mr. Aston*
- 535-536. ORGANIC CHEMISTRY (3 each) Adapted to the needs of those doing research work in organic chemistry. *Mr. Zook*
537. ORGANIC CHEMISTRY OF HIGH POLYMERS (3) High polymer theory and practice from the viewpoint of organic chemistry.
538. ORGANIC CHEMISTRY (3) Survey of organic chemistry arranged primarily for graduate students majoring in fields other than organic chemistry. *Messrs. Noll and Oakwood*
539. STEREOCHEMISTRY (3) Comprehensive treatment of the principles of stereochemistry as applied to organic compounds. *Mr. Oakwood*
540. EXPERIMENTAL METHODS OF PHYSICAL CHEMISTRY (3-5)
541. PHASE RULE (3) The phase rule and its applications.
542. COLLOIDS (3) The physics and chemistry of surfaces and their resulting colloid properties; methods of preparing colloids. *Mr. Smith*
544. CHEMICAL THERMODYNAMICS (3) Development of thermodynamic theory with special reference to common physical changes and chemical reactions. Prerequisite: Chem. 461. *Messrs. Aston and Fritz*
545. CHEMICAL THERMODYNAMICS AND INTRODUCTORY STATISTICAL MECHANICS (3) Continuation of Chem. 544 including the calculation of thermodynamic properties from molecular and spectroscopic data. Prerequisite: Chem. 544. *Messrs. Aston and Fritz*
546. QUANTUM CHEMISTRY (3) Calculation of electronic properties of atoms and molecules by wave mechanical methods including molecular orbital theory. Prerequisite: Chem. 565. *Messrs. Aston and Goodman*
547. STATISTICAL MECHANICS (3) Properties of matter at equilibrium, developed on the basis of energy levels of molecules and statistical mechanical theory. Prerequisite: Chem. 565. *Mr. Aston*
548. CATALYSIS (3) Theory of catalysis and its application to industry.
549. PHYSICAL CHEMISTRY OF HIGH POLYMERS (3) Physicochemical principles related to the properties of synthetic and natural polymeric systems.
560. TOPICS IN PHYSICAL CHEMISTRY (3-12)
- 561-562. CHEMICAL PRINCIPLES (3 each) Mathematical treatment of the classical principles of chemistry; their application to problems. Required of all graduate students. Prerequisites: Chem. 461, Math. 43, Phys. 285. A course in organic chemistry is recommended.

563. CHEMICAL KINETICS (3) Theory and measurement of the rates of chemical reactions; the mechanism of chemical reactions. *Messrs. Ascah and Taft*
564. CHEMICAL KINETICS (3) Continuation of Chem. 563 but including theory and measurement of photochemical reactions. *Messrs. Ascah and Taft*
565. ATOMIC AND MOLECULAR STRUCTURE (3) Introduction to modern theoretical chemistry: chemical bonds and molecular spectra.
567. ADVANCED THEORETICAL CHEMISTRY (3) Modern and current theories of the properties of chemical substances and their applications to chemical problems; the construction of chemical theory.
581. EXPERIMENTAL METHODS IN PETROLEUM CHEMISTRY (1-12)
582. TOPICS IN PETROLEUM CHEMISTRY (2-6)

## CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS

WINONA L. MORGAN, *Head of the Department*  
19A Home Economics Building

*Degrees Conferred:* M.S., M.Ed. in the general field of Child Development and Family Relationships; Ph.D., D.Ed. in Child Development and in Family Relationships.

*Graduate Faculty:* Professors Harms, Morgan, and Smith; Associate Professors Britton and Siegel.

Students may specialize in the guidance and development of children, relationships among various members of the family, problems of all stages of the family cycle, nursery school education, education for home and family living in the schools, parental education, and work with children and families in community agencies.

The entering student should have had at least 6 credits in the physical and biological sciences, 12 in the social sciences (which must include a basic course in sociology and one in psychology), and 6 in child development and family relationships. Students who are otherwise qualified but who lack some of these credits may be admitted and permitted to make up the deficiency credits along with a graduate program.

### CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS (CD FR)

- |                                                         |                     |
|---------------------------------------------------------|---------------------|
| 418. FAMILY RELATIONSHIPS (3)                           |                     |
| 429. ADVANCED CHILD DEVELOPMENT (3)                     | <i>Miss Avery</i>   |
| 430. OBSERVATION AND EXPERIENCE IN NURSERY SCHOOL (1-4) | <i>Miss Russell</i> |
| 441. NURSERY SCHOOL ORGANIZATION (3)                    | <i>Miss Russell</i> |
| 445. (Psy. 445). DEVELOPMENT THROUGHOUT ADULTHOOD (3)   | <i>Mr. Britton</i>  |
| 481. EDUCATIONAL METHODS WITH PRESCHOOL CHILDREN (3)    | <i>Miss Russell</i> |



## CHILD DEVELOPMENT

### 500. NONTHESIS RESEARCH (1-6)

508. PARENTAL EDUCATION (3) Discussion and use of methods, experiences, and programs which can be used effectively to help parents in dealing with problems of parent-child relationships. Prerequisites: C.D.F.R. 429, 430.

Miss Morgan

515. THE TEACHING OF CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS (3) Methods of selection and presentation of subject matter basic to understanding the development of children.

Miss Morgan

529. (Psy. 529). SEMINAR IN CHILD DEVELOPMENT (1-6) Readings and reports on recent findings in child development. Prerequisites: 6 credits in child development or 6 in educational or child psychology, plus 3 in statistics.

530. PROBLEMS IN CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS (1-6) Problems involving individual research in library, laboratory, or field projects.

539. THEORIES OF CHILD DEVELOPMENT (3) Historical background of the major theories concerning child development and behavior and their application.

Miss Morgan

545. THE FAMILY IN ITS COMMUNITY (3) Cultural influences on family relationships; how the family orients its members to community living and group participation.

546. SEMINAR IN FAMILY RELATIONSHIPS (1-6) Reading, reports, and discussion of recent research in relationship aspects of family living; particular attention to studies of roles, crises, and adjustments within the family setting.

## CIVIL ENGINEERING and SANITARY ENGINEERING

BENJAMIN A. WHISLER, *Head of the Department of Civil Engineering*  
208 Sackett Building

*Degrees Conferred:* Civil—Ph.D., M.S., M.Eng.; Sanitary—M.S., M.Eng.

*Graduate Faculty:* Professors Gillan, Kountz, Perez, Reen, Shulits, and Whisler; Associate Professors Moore and Underwood; Assistant Professor Nesbitt.

The entering student should be a graduate in civil engineering from an accredited college of engineering. Students may specialize in structures, hydraulics, transportation engineering, surveying, and sanitary engineering, or combinations of these, through courses offered both by the Department of Civil Engineering and by other departments of the University.

### CIVIL ENGINEERING (C E)

400. SEMINAR (1-3)

401. CIVIL ENGINEERING PROJECTS (2-12)

412. ADVANCED PHOTOGRAMMETRY (3)

## CIVIL ENGINEERING

- 421. HIGHWAYS AND STREETS (3)
- 423. HIGHWAY SAFETY AND TRAFFIC CONTROL (3)
- 431. CIVIL ENGINEERING CONSTRUCTION (3)
- 441. STATICALLY INDETERMINATE STRUCTURES (3)
- 442. STATICALLY INDETERMINATE STRUCTURES (3)
- 446. ADVANCED SOIL MECHANICS (3)
- 451. ADVANCED HYDROLOGY (3)
- 462. ADVANCED HYDRAULICS (3)
- 465. ELEMENTS OF HYDRAULIC ENGINEERING (3)
- 466. HYDRAULIC MACHINERY (3)
- 471. MUNICIPAL AND RURAL SANITATION (3)
- 472. TREATMENT PLANTS (4)
- 473. WATER AND SEWAGE ANALYSIS (3)
  
- 500. SEMINAR IN CIVIL ENGINEERING (1-6) Reports on researches and special topics. Course may be continued in subsequent semesters.
  
- 521. TRANSPORT PLANNING AND DESIGN (2-6) Planning and design of transportation facilities; basic principles and engineering techniques applied to airways, highways, pipe lines, railways, waterways. Prerequisite or concurrent: C.E. 51 or 421.
  
- 522. TRANSPORT OPERATION AND MAINTENANCE (2-6) Engineering problems in operation, maintenance, and administration of airways, highways, pipe lines, railways, waterways. Prerequisite or concurrent: C.E. 51 or 421.
  
- 540. ADVANCED STRUCTURAL ANALYSIS (2-4) Geometry of flexure, deflections; analysis of continuous beams, rigid frames, arches; influence lines. Prerequisite: C.E. 40.
  
- 541. ADVANCED STRUCTURAL ANALYSIS (2-4) Truss deflection; trusses with redundant members, continuous trusses, framed arches; influence lines; secondary stresses; wind stresses; space framework; suspension bridges. Prerequisite: C.E. 40.
  
- 542. APPLIED SOIL MECHANICS (2-5) Soil classification by type of clay minerals and profile development; aerial photographic interpretation of soils and applications to site selection for dams, highways, and airports. Prerequisites: C.E. 412, Geol. 71.
  
- 543. STRUCTURAL ENGINEERING PROJECTS (3-10) Investigation or design projects in concrete, soil mechanics, photoelasticity, analysis, etc. Prerequisite or concurrent: C.E. 441, 442.
  
- 544. ADVANCED STRUCTURAL DESIGN (2-4) Plain and reinforced concrete design as applied to buildings, bridges, retaining walls, domes, tanks, and dams; prestressed concrete. Prerequisites: C.E. 42, 442.
  
- 545. ADVANCED STRUCTURAL DESIGN (2-4) Structural steel design as applied to riveted and welded girders, trusses, rigid frames, wind connections; timber design. Prerequisite: C.E. 41.
  
- 547. ADVANCED STRUCTURAL THEORY (3-6) Prestressed concrete, arches, suspension bridges, concrete dams, thin shells, and other current topics. Prerequisites: C.E. 441, 442.
  
- 550. ENGINEERING CONSTRUCTION (2-4) Construction methods applied to foundations, buildings, bridges, and other civil engineering construction work. Prerequisites: C.E. 41, 42.

## CIVIL ENGINEERING

551. HYDROLOGIC INVESTIGATIONS (2-8) Application of hydrologic principles and techniques to a specific project. Prerequisite: C.E. 451.
560. THEORY OF HYDRAULIC MODELS (3) Application of dimensional analysis and similitude to models used in the study of problems in hydraulics.
564. HYDRAULIC ENGINEERING DESIGN (2-8) Design and analysis of selected units of a typical hydraulic engineering project.
565. TRANSPORTATION OF SOLIDS BY FLUIDS (2-5) Fundamentals of the flow of solids in open and closed conduits; e.g., suspended load and bed load in rivers, slurries and pulp stocks in pipes.
566. FLUID MECHANICS OF HYDRAULIC MACHINERY (3) Advanced theory and design of hydraulic machinery. Prerequisite: C.E. 466.
570. RURAL SANITATION DESIGN (3) Requirements and devices essential to rural sanitary problems: water supply, excreta disposal, industrial waste treatment. Not intended for civil or sanitary engineering students. Prerequisites: Chem. 4, Phys. 285.
571. WATER PURIFICATION AND SOFTENING (3) Current methods of softening, disinfecting, and conditioning water for municipal and industrial use. Prerequisite: C.E. 70.
572. SEWAGE TREATMENT (3) Modern methods of sewage treatment. Prerequisite: C.E. 70.
573. ADVANCED PROBLEMS IN SANITARY ENGINEERING (3-10) Continuation of C.E. 474 on a graduate level. Prerequisite: C.E. 474.
575. ADVANCED INDUSTRIAL WASTE TREATMENT (3) Techniques of industrial waste treatment; attendant stream pollution and stream self-purification factors. Prerequisite: C.E. 472 or 572.
576. WATER TREATMENT PLANT DESIGN (1-6) Design of works for treatment of water for municipal and industrial use. Prerequisite: C.E. 71.
577. SEWAGE TREATMENT PLANT DESIGN (1-6) Design of works for treatment of sewage or industrial wastes. Prerequisite: C.E. 71.
578. INDUSTRIAL HYGIENE (3) Principles of control of industrial toxics and the protection of the worker and the community.
579. PUBLIC HEALTH ADMINISTRATION (3) Operation and duties of health departments at the various levels.

## CLINICAL SPEECH

EUGENE T. McDONALD, *Director of the Speech and Hearing Clinic*  
2S Sparks Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professor McDonald; Associate Professors Berlin, Frick, and Siegenthaler; Assistant Professor Raabe.

Students may specialize in either speech correction or audiology. Admission to study for the master's degree requires 27 semester hours in clinical speech and



hearing, education, and psychology courses. These must include at least 9 credits in speech correction and/or audiology. Applicants for the M.Ed. degree must have had student teaching. Applicants for the M.S. degree may count credits in speech science toward the required 27 hours.

# SPEECH EDUCATION (SP ED)

- 430. HEARING PROBLEMS AND THE TESTING OF HEARING (3)
- 434. AUDIOMETRY AND HEARING AIDS (3)
- 435. CLINICAL PRACTICE WITH THE HEARING HANDICAPPED (1-6)
  - Unit A. Audiologic Evaluation and the Selection of Hearing Aids (1-4)*
  - Unit B. Auditory Training and Speech Reading (1-4)*
- 436. INTRODUCTION TO SPEECH CORRECTION (3)
- 437. CLINICAL PRACTICE IN SPEECH CORRECTION (1-3)
- 440. SPEECH EDUCATION FOR THE CLASSROOM TEACHER (2-3)
- 441. CURRENT PROBLEMS IN SPEECH AND HEARING (1-6)
- 442. SPEECH PATHOLOGY (3)
- 443. METHODS IN AUDITORY TRAINING AND SPEECH READING (3)
- 445. THE PUBLIC SCHOOL SPEECH CORRECTION PROGRAM (3)
  
- 525. SEMINAR IN CLINICAL SPEECH PATHOLOGY (3-9) Prerequisites: Sp.Ed. 436, 442.
  - Unit A. Cleft Palate*
  - Unit B. Cerebral Palsy*
  - Unit C. Aphasia*
  
- 530. SEMINAR IN AUDIOLOGY (2-4) Review of theories of hearing and review of related physiological and psychological researches. Prerequisite: Sp.Ed. 434.
  
- 537. ADVANCED CLINICAL PRACTICE IN SPEECH CORRECTION (1-9) Prerequisites: Sp.Ed. 437, 442.
  - Unit A. Diagnostic Procedures (1-3)*
  - Unit B. Treatment Procedures (1-6)*
  
- 540. ARTICULATION DISABILITIES (3) Speech-sound production disorders in children and adults; methods of examination, diagnosis, and treatment. Prerequisites: Sp.Ed. 437, 442.
  
- 541. THE VOICE AND ITS DISORDERS (3) Physical, physiological, and psychological bases of voice production; causes, nature, and symptoms of its disorders; current clinical methods in voice improvement. Prerequisites: Sp.Ed. 437, 442.
  
- 542. STUTTERING AND ALLIED DISORDERS (3) Modern theories of causes of disorders of rhythm; methods of examination, diagnosis, and treatment. Prerequisites: Sp.Ed. 437, 442.
  
- 543. DIAGNOSTIC PROCEDURES IN CLINICAL SPEECH (3) Clinical instrumentation; case history taking; examination procedures and materials used in diagnosing speech disabilities; interpretation of findings; report preparation. Prerequisites: Sp.Ed. 437, 442.

## CLOTHING AND TEXTILES

### CLOTHING AND TEXTILES

RUTH W. AYRES, *Head of the Department*  
116A Home Economics Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

Work may be taken with major emphasis in the textile area, which stresses the background natural sciences, or in the clothing area, which stresses the background social sciences. Candidates are accepted who have a strong foundation and a good record in any of the following: home economics, chemistry, sociology, economics, or psychology.

#### CLOTHING AND TEXTILES (CL TX)

- 400. SPECIAL PROBLEMS IN CLOTHING AND TEXTILES (1-6)
- 402. FUNDAMENTAL PRINCIPLES OF TAILORING CONSTRUCTION (3)
- 403. CREATIVE PATTERN MAKING (3)
- 404. DRAPING (3)
- 406. FASHION PROMOTION (3)
- 407. THE TEXTILE AND CLOTHING INDUSTRY (3)
- 408. INTERMEDIATE TEXTILES (3)
- 410. CLOTHING FOR THE FAMILY (3)
- 411. ADVANCED CLOTHING CONSTRUCTION (3)
- 413. TEXTILE TECHNOLOGY (3)
  
- 500. NONTHESIS RESEARCH (1-6)
  
- 503. ADVANCED PATTERN DEVELOPMENT (3) Analysis of advanced pattern designing principles to give students facility in original designing.
- 504. ADVANCED DRAPING (3) Analysis of principles and techniques as a basis for creation of original designs; survey of literature in dress design.
- 505. CLOTHING INSTRUCTIONAL MATERIALS (3) Development of instructional materials and techniques based on needs of diverse groups.
- 506. THE FASHION WORLD (3)
- 507. PROBLEMS IN RELATION TO CLOTHING CONSUMPTION (3) Problems connected with manufacture and consumption of clothing; interrelation of textile and clothing trades with other industries.
- 508. SPECIAL PROBLEMS IN CLOTHING AND TEXTILES (1-6) Individual directed study, investigation, and practice in selected phases of textiles and clothing.
- 509. SEMINAR IN CLOTHING AND TEXTILES (1-6)
- 510. RESEARCH METHODS AND EVALUATION IN CLOTHING AND TEXTILES (1-6)
- 511. CURRENT DEVELOPMENTS IN CLOTHING AND TEXTILES (1-6)
- 512. HISTORY OF CLOTHING AND CLOTHING CONSTRUCTION (3)
- 513. ADVANCED TEXTILE TECHNOLOGY (6)

## COMPARATIVE LITERATURE

PHILIP A. SHELLEY

*Chairman of the Committee on Comparative Literature*  
229 Sparks Building

*Degrees Conferred:* Ph.D., M.A.

Programs are arranged through a meaningful selection of courses offered by the several departments of languages and literatures, both ancient and modern, as well as of those specifically in the category of comparative literature. More than a minimum knowledge of foreign languages is required.

### COMPARATIVE LITERATURE (C LIT)

400. COMPARATIVE METHOD IN LITERARY STUDIES (3)  
443. (Ger. 443). LITERARY RELATIONS OF GERMANY WITH ENGLAND AND AMERICA (3-9) *Mr. Shelley*  
480. INTRODUCTION TO FOLKLORE (3) *Mr. Bayard*  
500. SEMINAR IN COMPARATIVE LITERATURE (3-6)  
508. NORSE AND GAELIC SAGAS (3) Medieval Irish and Scandinavian prose tales surveyed and compared with respect to backgrounds, development, themes, and characteristics.

## COUNSELING IN EDUCATION

GEORGE R. HUDSON, *in Charge of the Graduate Program*  
418 McAllister Hall

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.  
*Graduate Faculty:* Professor Wellington; Assistant Professor Hudson; Mr. Hylbert.

Professional preparation programs are offered at the master's level for elementary or secondary school counselors, home and school visitors, college counselors, and rehabilitation counselors. Doctoral programs prepare for pupil personnel administration, college student personnel administration, or supervision of rehabilitation.

All candidates for graduate degrees in counseling in education must present for admission at least 27 undergraduate credits in economics, education, psychology, sociology, and physiology or anatomy, with some credits in at least three of these areas.

Prospective school counselors and home and school visitors must have a teaching certificate to enter the program and must have two years of teaching experience before receiving a degree. Those wishing to become college counselors must have a year of college teaching or college personnel experience to qualify for a degree. Since graduate students in rehabilitation counseling combine a supervised internship with professional training, their master's degree program is correspondingly lengthened.



## COUNSELING IN EDUCATION

A candidate for either a Ph.D. or a D.Ed. degree in counseling in education must spend at least two semesters in residence after earning the master's degree; during this time his employment load must be limited to half-time at most, the balance of his time being devoted to graduate study.

The following courses are used in the graduate programs of majors in counseling in education: Ed.Ser. 403, 404, 408, 409, 474, 490, 494, 503, 505, 506, 507, 508, 509, 511, 512, 522, 551, 598, 600, 610; Psy. 414, 418, 426, 436, 437, 445, 450, 482, 502, 535; Soc. 403, 426, 427, 450; Ch.Fm. 405; Pl.Sc. 433; Anthy. 402; Econ. 404.

## DAIRY SCIENCE

DONALD V. JOSEPHSON, *Head of the Department*  
105 Dairy Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Almquist, Doan, Josephson, and Williams; Associate Professors Flipse, Kesler, Patton, and Watrous; Assistant Professors Keeney and O'Dell.

Students may specialize in dairy products manufacture, chemistry of milk and dairy products, dairy cattle nutrition, dairy cattle management, and physiology of reproduction. The minor program is generally taken in agricultural and biological chemistry, bacteriology, zoology, or agricultural economics.

Prerequisite to graduate work is the completion of an undergraduate curriculum in dairy science or a related science area. The undergraduate program must include college algebra and general physics. Students may be admitted with limited deficiency but are required to make up undergraduate deficiency work without degree credit.

### DAIRY SCIENCE (D SC)

- |                                                                                                                                                                  |                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| 418. DAIRY SURVEY (1)                                                                                                                                            | Mr. Josephson        |
| 421. DAIRY MANUFACTURING PROBLEMS (1-6)                                                                                                                          | Mr. Doan and Staff   |
| 427. MILK SECRETION (3)                                                                                                                                          | Mr. Kesler           |
| 428. DAIRY PRODUCTION PROBLEMS (1-3)                                                                                                                             | Mr. Kesler and Staff |
| 430. TECHNICAL CONTROL OF DAIRY PRODUCTS (4)                                                                                                                     | Mr. Watrous          |
| 431. PHYSIOLOGY OF REPRODUCTION IN FARM ANIMALS (3)                                                                                                              | Mr. Almquist         |
| 501. BUTTER AND CHEESE (1-6) Manufacture and handling of butter and cheese.<br>Prerequisites: D.Sc. 10, 23, Bact. 8, A.B.Ch. 403. Mr. Watrous                    |                      |
| 502. CONDENSED MILK AND MILK POWDER (1-6) Condensing and drying of milk.<br>Prerequisites: D.Sc. 10, 26, Bact. 8, A.B.Ch. 403. Mr. Doan                          |                      |
| 503. PUBLIC MILK PROBLEMS (1-6) Handling milk in modern plants. Pre-<br>requisites: D.Sc. 11, Bact. 8, A.B.Ch. 403. Mr. Doan                                     |                      |
| 504. ICE CREAM MANUFACTURE (1-6) Manufacture of ice cream, ices, and<br>other frozen milk products. Prerequisites: D.Sc. 11, Bact. 8, A.B.Ch. 403.<br>Mr. Keeney |                      |

## DAIRY SCIENCE

505. DAIRY PLANT ECONOMICS (1-6) Economic factors involved in creamery operation and management. Prerequisites: D.Sc. 7, 11. *Mr. Watrous*
507. DAIRY CATTLE MANAGEMENT (1-6) Management of dairy cattle. Prerequisite: D.Sc. 27. *Mr. Williams and Staff*
508. DAIRY SEMINAR (1-6) Preparation and presentation of a paper on an assigned subject. *Mr. Patton*
509. TESTING DAIRY PRODUCTS (1-6) Constituents of dairy products. Prerequisites: D.Sc. 11, Bact. 8, A.B.Ch. 403. *Mr. O'Dell*
510. DAIRY CATTLE FEEDING (1-6) Application of fundamental research in animal nutrition to the feeding of dairy cattle. Prerequisites: D.Sc. 1, 29. *Mr. Williams*
511. DAIRY CATTLE NUTRITION (1-6) Nutritional requirements of dairy cattle. Prerequisite: A.Ntr. 401. *Mr. Kesler*
512. ADVANCED STUDIES IN MILK SECRETION (1-6) Physiology of milk secretion. Prerequisite: D.Sc. 427. *Mr. Kesler*
513. DAIRY CATTLE SELECTION (1-6) Breed history, pedigrees, selection, and judging of dairy cattle. Prerequisites: D.Sc. 1, 30.
515. ADVANCED PHYSIOLOGY OF REPRODUCTION IN FARM ANIMALS (1-6) *Mr. Almquist*
516. ARTIFICIAL BREEDING OF FARM ANIMALS (1-6) Prerequisite: D.Sc. 431. *Mr. Almquist*
517. DAIRY SCIENCE LITERATURE (1-6) Review and reporting of dairy literature. *Mr. Josephson and Staff*
522. RESEARCH PROCEDURES IN DAIRY TECHNOLOGY (3) Research problems and methods in dairy technology with major emphasis on dairy chemistry. Prerequisite: A.B.Ch. 403. *Mr. Patton*

## ECONOMICS

MONROE NEWMAN, *Head of the Department*  
124 Boucke Building

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Professors Cutler, Fouraker, Hench, Reede, Saylor, and Stout; Associate Professors Kaufman, Kautz, Mares, Martin, Mason, Myers, Newman, and Sauerlender; Assistant Professors Helfgott, Klein, Prybyla, and Werboff.

Opportunities are available for concentration in business statistics, economic theory, labor, international economics, government economic policy, money, credit, and public finance.

To enter graduate work in economics a student should have completed 6 credits in economic principles, 9 in the social sciences, and either 3 in statistics or 6 in mathematics.

## ECONOMICS

### BUSINESS STATISTICS (B S)

- 500. SEMINAR IN BUSINESS STATISTICS (3)
- 501. ADVANCED BUSINESS STATISTICS (3)

### ECONOMICS (ECON)

- 400. HISTORY OF ECONOMIC THOUGHT (3)
- 404. ECONOMIC FRAMEWORK OF MODERN SOCIETY (3)
- 405. INTERMEDIATE ECONOMIC THEORY (3)
- 406. ECONOMIC GROWTH AND DEVELOPMENT (3)
- 412. ECONOMICS OF COLLECTIVE BARGAINING (3)
- 415. SOCIAL INSURANCE (3)
- 418. ECONOMICS OF WAGES AND EMPLOYMENT (3)
- 419. CASE STUDIES IN LABOR-MANAGEMENT RELATIONS (3)
- 423. STATE AND LOCAL TAXATION (3)
- 425. THE MONEY MARKETS (3)
- 428. INCOME AND EMPLOYMENT THEORY (3)
- 429. FEDERAL FINANCES (3)
- 433. INTERNATIONAL MONETARY ECONOMICS (3)
- 434. INTERNATIONAL TRADE AND PUBLIC POLICY (3)
- 442. MONOPOLY, COMPETITION, AND THEIR REGULATION (3)
- 450. THE BUSINESS CYCLE (3)
- 480. MATHEMATICAL ECONOMICS (3)
- 490. MEASUREMENT OF THE ECONOMY (3)
- 499. FOREIGN STUDY IN ECONOMICS (2-6)
  
- 500. ECONOMICS SEMINAR (3-6)
- 501. RESEARCH METHODS IN ECONOMICS (3-6) Fall semester.
- 506. PROBLEMS IN ECONOMICS (3-6) Planned individual projects involving library, laboratory, or field work.
- 507. SEMINAR IN INTERNATIONAL ECONOMICS: THEORY AND POLICY (3-6) Spring semester, even years.
- 508. SEMINAR IN MONEY, CREDIT, AND PUBLIC FINANCE (3-6) Prerequisite: Econ. 51. Spring semester, odd years.
- 510. ECONOMETRICS (3) Statistical estimation in mathematically formulated economic relationships. Spring semester, even years.
- 511. SEMINAR IN INDUSTRIAL DISPUTES (3) Prerequisites: Econ. 14, 15. Fall semester, even years.
- 512. WAGES (3) Fall semester, odd years.
- 513. DEVELOPMENT OF ECONOMIC DOCTRINES (3-6) Prerequisite: Econ. 405. Spring semester.
- 515. LABOR SEMINAR (3) Spring semester.
- 522. ADVANCED ECONOMIC THEORY (3-6) Theory of price and income determination. Prerequisite: Econ. 405. Fall semester, micro; spring semester, macro.



# EDUCATIONAL ADMINISTRATION

FRANKLIN A. MILLER

*Head of the Department of Educational Services*  
207E Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Bixby, Cologne, Davison, DeLacy, Long, McGarey, Miller, Neuber, and Remaley; Associate Professors Bosch and McAulay; Assistant Professors Page and Willower.

Professional preparation programs are offered at the master's level for elementary and secondary school principals and supervisors. Doctoral programs prepare for positions of supervising principal, assistant superintendent, and superintendent of schools.

Requirements for admission to a graduate program in educational administration include 18 approved undergraduate credits in education and psychology. Applicants for admission to the master's degree program are required to have had one year of teaching experience, or to be currently engaged in teaching. Two years of teaching experience are required for admission to the doctoral program.

Candidates may minor in either educational foundations or in a field outside of education. While candidates are required to specialize in a field of professional education, they are also encouraged to acquire a general education in the social sciences, the behavioral sciences, and the humanistic foundations.

The following courses in educational administration are listed under the offerings of the Department of Educational Services: Ed.Ser. 480 and 565 to 582 inclusive. Additional courses may be selected from other areas and departments to meet the student's needs, including certification requirements.

## DEPARTMENT OF EDUCATIONAL SERVICES

FRANKLIN A. MILLER, *Head of the Department*  
207E Burrowes Building

The Department of Educational Services offers graduate programs in counseling in education, clinical speech, educational administration, and higher education. It also offers a number of course sequences which are not graduate majors.

The following courses, designated as Educational Services, carry graduate credit and, with the approval of the student's adviser, may be applied toward the requirements for an advanced degree in any major field:

	ED.SER.
Adult Education	460-462
Counseling in Education	403-409, 503-513
Educational Administration	480, 565-582
Higher Education	545-555
History and Philosophy of Education	415-424, 516-523
Instructional Materials	435-445, 535-541
Research, Seminars, and Projects	596-599
Safety Education	450-452
Special Education	425-431, 525-529
Testing and Measurements	490-494, 590-595

## EDUCATIONAL SERVICES

### EDUCATIONAL SERVICES (ED SER)

- 403. GUIDANCE PRINCIPLES AND PRACTICES (3)
- 404. TEACHING AND GROUP GUIDANCE ABOUT OCCUPATIONS (3)
- 408. INTRODUCTION TO VOCATIONAL REHABILITATION (3)
- 409. MEDICAL INFORMATION FOR COUNSELORS (3)
- 415. CHARACTER EDUCATION (2-3)
- 417. PHILOSOPHIC BASIS OF EDUCATION (3)
- 418. HISTORY OF EDUCATION IN THE UNITED STATES (2-3)
- 419. MODERN TENDENCIES IN AMERICAN EDUCATION (1-6)
- 420. HISTORY OF MODERN EUROPEAN EDUCATION (3)
- 424. RELIGIOUS EDUCATION (2-3)
- 425. EDUCATION OF EXCEPTIONAL CHILDREN (2-3)
- 427. EDUCATION OF THE MENTALLY RETARDED (2-3)
- 429. EDUCATION OF THE MENTALLY GIFTED CHILD (1-3)
- 430. PRACTICUM IN THE EDUCATION OF ATYPICAL CHILDREN (1-8)
- 431. ATYPICAL CHILDREN AND EDUCATIONAL ADJUSTMENTS (3)
- 435. VISUAL AND OTHER SENSORY AIDS FOR TEACHERS (1-3)
- 436. PREPARATION OF EDUCATIONAL STILL PICTURES (2-3)
- 437. SCRIPTING AND SHOOTING EDUCATIONAL MOTION PICTURES (2-3)
- 438. EDITING AND SOUND RECORDING IN THE PRODUCTION OF EDUCATIONAL MOTION PICTURES (2-3)
- 441. ORGANIZATION AND ADMINISTRATION OF VISUAL-SENSORY AIDS PROGRAMS (1-3)
- 442. MOTION PICTURES IN EDUCATION (2-3)
- 443. RADIO AND TELEVISION IN EDUCATION (3)
- 444. STILL PICTURES (1-2)
- 445. ADVANCED AUDIO-VISUAL EQUIPMENT (3)
- 450. VISUAL AND OTHER AIDS IN SAFETY EDUCATION (3)
- 451. TEACHING TRAFFIC SAFETY AND AUTOMOBILE OPERATION (3)
- 452. ORGANIZATION AND SUPERVISION IN SAFETY EDUCATION (3)
- 460. HISTORY, PHILOSOPHY, AND GENERAL ORGANIZATION AND ADMINISTRATION OF ADULT EDUCATION (1)
- 461. ORGANIZATION, TYPES, AND METHODS OF ADULT EDUCATION AND PARENTAL EDUCATION (1)
- 462. METHODS IN ADULT EDUCATION AND LEADERSHIP OF DISCUSSION GROUPS (1)
- 480. EDUCATIONAL ADMINISTRATION (2-3)
- 490. EDUCATIONAL STATISTICS AND MEASUREMENTS (2-3)
- 494. EDUCATIONAL TESTING PROGRAMS (3)
  
- 503. GUIDANCE SERVICES IN ELEMENTARY EDUCATION (3) Guidance services to elementary school students; guidance opportunities for elementary teachers and principals.
  
- 505. OCCUPATIONAL AND EDUCATIONAL INFORMATION (3) Occupational information for guidance purposes; educational information related to vocational choice and preparation. Prerequisite: Ed.Ser. 403.
  
- 506. STUDENT ANALYSIS PROCEDURES FOR COUNSELORS (3) Collection and use of data basic to the counselor's understanding of individuals; the counseling interview and techniques other than testing.

## EDUCATIONAL SERVICES

507. SUPERVISED EXPERIENCE IN STUDENT COUNSELING (3) Practice in the application of guidance principles and methods to cases counseled under supervision; case conferences; seminar in guidance techniques. Prerequisite: Ed.Ser. 403.
508. ORGANIZATION AND ADMINISTRATION OF GUIDANCE PROGRAMS (3) Principles, organization, personnel, functions, integration with school program, evaluation. Prerequisite: Ed.Ser. 403.
509. CONTRIBUTIONS OF PROFESSIONAL PERSONNEL TO VOCATIONAL REHABILITATION (3) Contributions of medical, social, psychological, and other specialists through the team approach; professional ethics, medical problems. Prerequisites: Ed.Ser. 403, 408.
511. SUPERVISED PRACTICUM IN REHABILITATION COUNSELING (1-6) Application of principles and techniques of rehabilitation counseling to cases involving handicapped individuals. Prerequisites: Ed.Ser. 403, 408.
512. PROFESSIONAL EXPERIENCE IN REHABILITATION COUNSELING (1-6) Supervised internship with responsibility for a regular case load. Prerequisite: Ed.Ser. 511.
513. SUPERVISION OF GUIDANCE WORKERS (3) Practical experience in supervising and evaluating work of counselors. Prerequisite: Ed.Ser. 507.
516. SOCIAL FOUNDATIONS OF EDUCATION (2-4) Social institutions and functions and their relationship to public education; analysis of the functions assignable to formal education. Prerequisites: El.Ed. 311 or Sec.Ed. 252; Psy. 14.
517. ADVANCED PHILOSOPHY OF EDUCATION (2-4) Analysis of educational policy and practice for philosophic consistency and commitment; philosophical implication in selected educational literature.
518. EVOLUTION OF EDUCATIONAL THOUGHT (2-3) Rise of formal educational philosophy from Plato to John Dewey; preliminary reference to Chinese, Hindu, Chaldean, Persian, Hebrew, and Egyptian theories.
521. EDUCATION IN THE LATIN-AMERICAN COUNTRIES (2-3) Recent educational progress in Central and South America, with special reference to Mexico, Cuba, Puerto Rico, Brazil, Chile, and Argentina.
522. COMPARATIVE EUROPEAN EDUCATION (3) Educational policies and practices in school systems in western and central European nations. Prerequisite: Psy. 14.
523. EDUCATION IN RUSSIA, ASIA, AND THE MIDDLE EAST (2-3) Current educational activities in Soviet Russia and other eastern European countries; the Middle East, North Africa, and the Far East.
525. INTERNSHIP IN SPECIAL EDUCATION SUPERVISION (3-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
527. PROBLEMS IN THE EDUCATION OF THE MENTALLY RETARDED (1-4) Study of existing curriculums, instructional practices, educational programs; experimentation in curriculum building and materials construction. Prerequisites: teaching experience; Ed.Ser. 425 or 577, and Ed.Ser. 427.



## EDUCATIONAL SERVICES

529. PROBLEMS IN THE EDUCATION OF THE MENTALLY GIFTED (1-4) Analysis of educational needs of mentally gifted; curriculum construction and curricular materials. Prerequisites: teaching experience; Ed.Ser. 425 or 577, and Ed.Ser. 429.
535. SEMINAR IN CURRICULUM MATERIALS AND THEIR UTILIZATION (3) Advanced detailed analysis of mass communication media; relationships among these and educational objectives, individual differences in learners, and ideas to be communicated. Prerequisites: Ed.Ser. 435, Sec.Ed. 585, 6 credits in educational psychology.
540. INTERNSHIP IN AUDIO-VISUAL EDUCATION (3-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
541. LABORATORY IN ORGANIZATIONAL ASPECTS OF MATERIALS OF INSTRUCTION (1-3) Organizing, storing, circulating, and maintaining instructional material in an instructional materials library. Prerequisites: Ed.Ser. 435, Sec.Ed. 585. Conference 1 hour, alternate weeks by appointment.
545. HIGHER EDUCATION IN THE UNITED STATES (2-3) Historical perspective and current status; development of functions and structures; issues in curriculum, admissions, government, administration, and finance.
546. THE PRINCIPLES OF COLLEGE TEACHING (2-3) Principles involved in teaching at the college level; effective use of teaching aids; criteria used in evaluation.
547. INTERNSHIP IN COLLEGE TEACHING (3-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
548. CURRICULUMS IN HIGHER EDUCATION (2-3) Various types of curriculums and philosophies underlying them; ways in which curriculums are developed; elective versus required courses; evaluation of achievement.
549. COMMUNITY JUNIOR COLLEGE AND THE TECHNICAL INSTITUTE (2-3) Distinctive contributions to meeting the need for post-secondary education; development, functions, curriculum and instruction, government, administration and finance.
550. THE PROFESSIONAL EDUCATION OF TEACHERS (3) Development and present status of teacher education; objectives and standards; selection and guidance of students; personnel problems in relation to staff. Prerequisite: 6 credits in advanced courses in education and a course in educational psychology.
551. STUDENT PERSONNEL PROGRAMS AT THE COLLEGE LEVEL (2-3) Student personnel services in higher education; organization of student advisory programs; use of personnel data; co-curricular activities; student welfare.
552. ADMINISTRATION IN HIGHER EDUCATION (2-3) Philosophy of administration; principles of scientific management and their application in colleges and universities; case studies of administrative problems. Prerequisite: courses or experience in higher education.
555. SEMINAR IN COLLEGIATE EDUCATION (1-6) Special topics in higher education. Prerequisite: courses or experience in higher education.

## EDUCATIONAL SERVICES

565. **PRINCIPLES OF SCHOOL SUPERVISION (2-3)** Organization of supervision; planning the supervisory program; developing standards of teaching and learning; improvement of learning through tests and teacher rating. Prerequisites: 18 credits in education and 3 years' teaching experience.
566. **THE ELEMENTARY SCHOOL PRINCIPAL AS SUPERVISOR (2-3)**
567. **THE SECONDARY SCHOOL PRINCIPAL AS SUPERVISOR (2-3)** Improvement of instruction; improvement of teachers in service; evaluation of teaching procedures; methods of supervision; selection and use of textbooks. Prerequisite: three years' teaching experience.
568. **THE ELEMENTARY SCHOOL PRINCIPAL AS ADMINISTRATOR (2-3)** Duties of the elementary school principal in organizing and administering his school.
569. **THE SECONDARY SCHOOL PRINCIPAL AS ADMINISTRATOR (2-4)** Problems of schedule making, teachers' meetings, curriculum making and revision, organization of extracurricular and guidance programs. Prerequisite: teaching experience.
570. **ADMINISTRATION AND SUPERVISION IN BUSINESS EDUCATION (3)** Work of administrators, supervisors, and others responsible for improvement of instruction in business education; use of vocational testing; job analysis. Prerequisite: 6 credits in secondary education.
571. **THE EDUCATIONAL PLANT (2-3)** School plant needs in terms of school population and curriculums; the building survey, developing a plant program, the building site, plant utilization, operation and maintenance, heating and ventilation, equipment, school building costs and finance. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
572. **PUBLIC RELATIONS FOR SCHOOL ADMINISTRATORS (2-3)** Utilization of public participation in the formulation of school policies; relation of the school staff to the public and techniques for informing the public about what schools can do. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
573. **PUBLIC SCHOOL FINANCE (2-3)** Financing of public education in relation to organization and control; the conceptual basis for local financial administration; taxation, state and federal aid, school revenue, and money management. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
574. **STATE AND NATIONAL EDUCATION PROGRAMS (2-3)** Existing state and federal functions and relations to education; proposed programs. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience, and previous work in school administration.
575. **ADMINISTRATION OF ADULT EDUCATION IN THE PUBLIC SCHOOLS (3)** The organization of a program of adult education; its legal status, finances, selection of teachers, learning personnel, housing, and other administrative problems connected with adult education. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
576. **LEGAL ASPECTS OF SCHOOL ADMINISTRATION (3)** Legal bases for the organization and administration of school districts and schools; the powers, rights, privileges, and responsibilities of school corporations, school boards, adminis-



## EDUCATIONAL SERVICES

- trators, and personnel; the law and fiscal policies; the course of study, textbooks; contracts; taxes; torts; records; agents; and the judicial decisions involved. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
577. THE ADMINISTRATION OF PUBLIC SCHOOL EDUCATION FOR ATYPICAL CHILDREN (2-3) Problems connected with the instituting and organizing of classes for atypical children; the legal phases, finances, teaching personnel, pupil personnel, housing, equipment, courses of study, curriculum, etc. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
578. DYNAMIC FACTORS IN SCHOOL ADMINISTRATION (2-3) Factors which make for the improvement of public schools; influences with which administrators may work to improve the schools in their local situations; subsection of data on individual administrative situations to scientific check. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
579. PUBLIC SCHOOL BUSINESS ADMINISTRATION (2-3) Business management applied to school management problems; budgeting, accounting, purchasing, insurance, school equipment, cafeteria management; transportation, salaries, personnel management, and auxiliary and co-ordinate agencies. Prerequisites: Ed.Ser. 480 or teaching or administrative or supervisory experience; Ed.Ser. 573.
580. SEMINAR IN SCHOOL ADMINISTRATION (1-6) Efficiency in supervision, methods of diagnosis and evaluation of teaching and learning procedure, improving instruction, maintaining teacher morale, stimulating co-operative work. Prerequisites: Ed.Ser. 480, 6 credits in educational administration.
581. EDUCATIONAL SURVEY TECHNIQUES (2-3) Methods for appraisal of an educational program; planning for expansion, consolidation, or reduction of educational offerings. Prerequisites: Ed.Ser. 480, 6 credits in educational administration.
582. INTERNSHIP IN ADMINISTRATION AND SUPERVISION (1-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
590. ADVANCED EDUCATIONAL STATISTICS (2-4) Appropriate measures and devices for experimental research in education including correlation measures, curve fitting, and analysis of variance. Prerequisite: 12 credits of graduate work in education including Ed.Ser. 490 or Psy. 415.
595. INTRODUCTION TO THE ADVANCED STUDY OF EDUCATION (1-3) Methods of educational research; criticism of studies and theses in education; initiating research projects; summarizing results of research. Prerequisite: Ed.Ser. 490 or Psy. 415.
596. SEMINAR IN EDUCATION (1-3) Conferences and discussions designed to meet the need for special study of particular fields in education. Prerequisite: 12 credits of graduate work in education.
597. WORKSHOP IN CURRENT EDUCATIONAL PROBLEMS (1-6) For administrators, supervisors, experienced elementary and secondary teachers, guidance workers; administrative, supervisory, and instructional problems involved in an emerging educational program. Prerequisite: 12 credits of graduate work in education.



## EDUCATIONAL SERVICES

598. PROBLEMS, PROJECTS, AND AREA STUDIES IN EDUCATION (1-6) Independent work in the study of topics in education or the development of new curriculums, materials, or procedures for teaching. Prerequisites: 12 credits of graduate work in education and approval of the department head.
599. INTERNSHIP IN PUBLIC SCHOOL RESEARCH (3-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.

## ELECTRICAL ENGINEERING

ARTHUR H. WAYNICK, *Head of the Department*  
105 Electrical Engineering Building

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Professors Hall, Mentzer, Tarpley, and Waynick; Associate Professors Armington, Bowhill, Holt, Marsh, Pearson, Ross, Rowlands, Shields, and Volz; Assistant Professors Laird and Schmerling.

Course offerings and research facilities are available in the following areas: information theory, microwave theory and techniques, networks, computers (including digital, analog, and network analyzer), control, power conversion, servomechanisms, tubes and transistors, dynamical machine analysis, power dispatching, relay protection, and wave propagation.

The entering student must hold a bachelor's degree in engineering or science and have satisfactorily completed undergraduate course work in electrical circuits, machinery, and electronics.

### ELECTRICAL ENGINEERING (E E)

- 421a,b,c,d. ELECTRICAL ENGINEERING PROBLEMS (2-12)
422. CREATIVE ELECTRICAL ENGINEERING (3)
423. TRANSIENT PHENOMENA (3)
424. POWER FREQUENCY ELECTRONICS (3)
425. SYMMETRICAL COMPONENTS (3)
426. TRANSISTORS (3)
428. SERVOMECHANISMS (3)
432. ULTRA-HIGH-FREQUENCY TECHNIQUES (3)
435. ENGINEERING ANALYSIS (3)
436. DESIGN, CONSTRUCTION, AND TESTING OF VACUUM TUBES (3)
438. FUNDAMENTALS OF ELECTRIC WAVES (3)
439. PULSE TECHNIQUES (3)
440. VACUUM-TUBE CIRCUITS I (3)
441. VACUUM-TUBE CIRCUITS II (3)
450. ELECTRICAL NETWORK THEORY (3)
460. HIGH-VOLTAGE ENGINEERING (3)
461. FUNDAMENTALS OF POWER SYSTEM STABILITY (3)
470. ELECTRONIC ANALOG COMPUTERS (3)
471. LOGICAL DESIGN OF DIGITAL COMPUTERS (3)
520. SEMINAR (1) Required of all graduate students in electrical engineering. Conferences, reading, and presentation of technical papers.

## ELECTRICAL ENGINEERING

521. ADVANCED ELECTRICAL ENGINEERING PROBLEMS (2-12)
523. TRANSIENTS IN LINEAR SYSTEMS (3) Transient response of linear electric circuits and electromechanical systems including the application of operational methods of analysis to electrical and electromechanical problems. Prerequisite: E.E. 423.
524. ENGINEERING ELECTRONICS (3) Special problems dealing with design and application of electronic devices and systems; emphasis upon individual projects closely related to other phases of the student's graduate program.
525. SYMMETRICAL COMPONENTS (3) Polyphase circuits and machines under unbalanced conditions of operation including effects of rotating machines upon distribution and transmission system performance; characteristics of phase converters and single-phase operation of polyphase systems. Prerequisite: E.E. 425.
528. SERVOMECHANISMS (3) Advanced treatment of transient and steady-state behavior of closed-cycle control systems with special attention to stability and design of stabilizing controllers. Prerequisite: E.E. 428.
532. ULTRA-HIGH-FREQUENCY ENGINEERING (4) Theory of transmission lines, wave guides, resonant cavities, antennae, and wave propagation. Prerequisite: E.E. 432.
535. ENGINEERING ANALYSIS (3) Engineering applications of complex variables, conformal mapping methods and potential plotting. Laplace transform methods and stability criteria. Prerequisite: E.E. 435.
538. ELECTROMAGNETIC ENGINEERING (3) Electrical and magnetic fields, using the Maxwell-Lorentz equations as applied to vector fields and special solutions for antennae, wave guides, and other engineering applications. Prerequisite: E.E. 438.
550. COMMUNICATION NETWORKS (3) Methods of filter design using lattice networks; effects of dissipation on characteristics of filter networks; transient response of networks and design of equalizers. Prerequisite: E.E. 450.
570. ADVANCED ELECTRONIC ANALOG COMPUTERS (3) Theory and design of linear and nonlinear function generators for electronic analog computers; methods of synthesizing physical systems. Prerequisite: E.E. 470.
571. DIGITAL COMPUTATION AND CONTROL (3) Methods of analysis of digital computers; analysis of sampled-data systems for real-time control purposes.

## ELEMENTARY EDUCATION

CHARLES M. LONG, *Head of the Department*  
109 Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Bixby, Long, and Murphy; Associate Professors Bosch, Corle, Hunt, and McAulay; Assistant Professor Kranzer.

The graduate programs provide advanced professional preparation for kindergarten teachers, elementary school teachers, and curriculum specialists. For admission 18 credits in elementary education, including teaching experience, are required.

## ELEMENTARY EDUCATION

### ELEMENTARY EDUCATION (EL ED)

- 400. THE SCIENTIFIC DIRECTION OF LEARNING ACTIVITIES (2-4)
- 426. PROBLEMS OF ELEMENTARY SCHOOL ARITHMETIC (2-3)
- 433. TEACHING SOCIAL STUDIES IN THE ELEMENTARY GRADES (2-3)
- 436. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE ELEMENTARY SCHOOL (3)
- 437. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE ELEMENTARY SCHOOL (3)
- 438. TEACHING SCIENCE IN THE ELEMENTARY SCHOOL (1-3)
- 443. THE ELEMENTARY SCHOOL READING PROGRAM (2-3)
- 444. READING DISABILITIES (2-3)
- 445. TECHNIQUES IN REMEDIAL READING (2-6)
- 449. TEACHING CHILDREN'S LITERATURE (2-3)
- 453. SPECIAL PROBLEMS IN THE TEACHING OF ELEMENTARY SCHOOL ENGLISH (2-3)
- 461. ELEMENTARY EDUCATION (2-3)
- 467. ADVANCED THEORY OF KINDERGARTEN (3)
- 479. MEASUREMENT OF ACHIEVEMENT IN THE ELEMENTARY SCHOOL (2-3)
- 485. WORKSHOP IN SELECTED STUDIES IN ELEMENTARY EDUCATION (1-6)
  
- 511. SUPERVISION OF STUDENT TEACHERS (3) A course in supervision for master teachers, department heads, and college teachers with supervisory responsibilities in teacher education. Prerequisite: teaching experience and 18 credits in education, including at least 5 in methods.
  
- 520. INTERNSHIP IN ELEMENTARY EDUCATION (3-6) Internship to take place in schools or educational situations where not regularly employed under supervision of graduate faculty.
  
- 546. SEMINAR ON READING INSTRUCTION (2-12) Designed to appraise significant researches and to outline procedures and materials for research; reading readiness, word perception, basic reading skills, vocabulary development. Prerequisite: El.Ed. 443 or Sec.Ed. 443.
  
- 556. READING CLINIC PRACTICE: ANALYSIS OF READING DISABILITIES (1-9) A laboratory course consisting of analysis of extreme reading disabilities and recommended remedial procedures; experience in preparation of case reports. Prerequisite: El.Ed. 444.
  
- 557. READING CLINIC PRACTICE: REMEDIAL PROCEDURES (1-9) Practicum in special classes for reading disabilities; corrective and remedial procedures; specific procedures for correction of various types of reading disabilities. Prerequisite: El.Ed. 444 or 556.
  
- 559. READING CLINIC RESEARCH (1-15) Prerequisites: El.Ed. 443; or Sec.Ed. 443, El.Ed. 444.
  
- 562. PROBLEMS OF ELEMENTARY EDUCATION (2-3) Problems seminar for experienced educators. Prerequisite: 12 credits in education and psychology, including 6 in elementary education.
  
- 563. SEMINAR IN CONTEMPORARY ISSUES IN ELEMENTARY EDUCATION (1-3) Conferences and discussions designed to meet the needs of experienced teachers and principals in the field of elementary education. Prerequisite: 6 credits in elementary education and teaching experience.



## ELEMENTARY EDUCATION

564. ORGANIZATION OF THE ELEMENTARY SCHOOL CURRICULUM (2-3) Principles underlying curriculum construction. Primarily for elementary education majors. Prerequisite: El.Ed. 311 or teaching experience.
585. WORKSHOP IN CURRENT ELEMENTARY SCHOOL PROBLEMS (1-6) For experienced elementary school teachers; administrative, supervisory, and instructional problems involved in an emerging educational program. Prerequisite: 12 credits of graduate work in education.
594. SEMINAR IN EDUCATION (1-3) Conferences and discussions designed to meet the need for special study of particular fields in education. Prerequisite: 12 credits of graduate work in education.
598. PROBLEMS, PROJECTS, AND AREA STUDIES IN ELEMENTARY EDUCATION (1-6) Independent work in the study of topics in elementary education or the development of new curriculums, materials, or procedures for teaching. Prerequisites: 12 credits of graduate work in education and approval of the department head.

## ENGINEERING MECHANICS

JOSEPH MARIN, *Head of the Department*  
204 Engineering A

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Professors Davids, Marin, Oppel, Vierck, and Wislicenus; Associate Professors Brennan, Hardenbergh, and Hu; Assistant Professor Jaunzemis.

Graduate study is available in dynamics and vibrations, theory of elasticity and strength of materials, experimental stress analysis, theory of plasticity, solid state mechanics, mechanical properties of materials, and fluid mechanics.

The entering student must hold a bachelor's degree in engineering or science and have satisfactorily completed undergraduate courses in statics, dynamics, and strength of materials.

### ENGINEERING MECHANICS (E MCH)

- |                                                   |                          |
|---------------------------------------------------|--------------------------|
| 400. ADVANCED STRENGTH OF MATERIALS (3)           | Mr. Hardenbergh          |
| 401. ELEMENTS OF VIBRATIONS (3)                   | Mr. Vierck               |
| 402. APPLIED AND EXPERIMENTAL STRESS ANALYSIS (3) | Mr. Oppel                |
| 403. MECHANICS OF THE SOLID STATE (3)             | Mr. Marin                |
| 404. RESEARCH IN ENGINEERING MECHANICS (1-6)      |                          |
| 407. NUMERICAL METHODS OF ANALYSIS (3)            | Mr. Vierck               |
| 408. ELASTICITY AND ENGINEERING APPLICATIONS (3)  | Messrs. Hu and Jaunzemis |
| 409. ADVANCED MECHANICS (3)                       |                          |
| 410. MECHANICS OF SPACE FLIGHT (3)                | Mr. Oppel                |
| 411. DETERMINATION OF MECHANICAL PROPERTIES (3)   |                          |
| 412. EXPERIMENTAL METHODS IN VIBRATIONS (3)       |                          |
| 413. PLASTIC ANALYSIS OF STRUCTURES (3)           | Mr. Hu                   |

## ENGINEERING MECHANICS

500. **ADVANCED MECHANICS OF MATERIALS (3-6)** Strain energy methods; special problems in bending and torsion; curved bars, beams on elastic foundations; thick-walled cylinders, shrink-fit assemblies, and rotating discs; thin-walled pressure vessels; bending of thin plates; buckling of bars and plates. Prerequisite: E.Mch. 13. *Mr. Marin*
504. **APPLIED ELASTICITY (3)** Analyses of stress and strain in two dimensions; problems in elasticity and elastic stability; emphasis on applications to machine and structural design. Prerequisite: E.Mch. 13.
506. **EXPERIMENTAL STRESS ANALYSIS (3)** Experimental methods of stress determination including photoelasticity, stress coat and electric strain gauge techniques; stress analogies; strain rosettes for combined stress determinations. Prerequisite: E.Mch. 408 or 507. *Mr. Oppel*
507. **THEORY OF ELASTICITY AND APPLICATIONS (3)** Equations of equilibrium and compatibility; stresses and strains in beams, curved members, rotating discs, thick cylinders, torsion and structural members. Prerequisite: E.Mch. 13.
508. **THEORY OF ELASTIC STABILITY AND APPLICATIONS (3)** Buckling of slender and short members; buckling of I-beams; stability of thin-walled constructions; thin-walled cylinders subjected to internal pressures; applications to structural parts including aircraft members. Prerequisites: E.Mch. 12, 13.
509. **THEORY OF PLATES AND SHELLS (3)** Bending of circular and rectangular plates; buckling of plates; plates on elastic foundations; deformation of shells without bending; applications to engineering problems. Prerequisite: E.Mch. 13. *Mr. Oppel*
514. **ENGINEERING MECHANICS SEMINAR (1 per semester)** Current literature and special problems in engineering mechanics.
516. **MATHEMATICAL THEORY OF ELASTICITY (3)** Stress and strain dyadics; conditions for single valued displacement; incompatibility dyadic; generalized Hooke's Law; uniqueness theorem; special topics in elasticity. Prerequisites: Math. 417, 405. *Mr. Jaunzemis*
520. **ADVANCED DYNAMICS (3)** Dynamics of a particle and of rigid bodies: Newtonian equations in moving co-ordinate systems; Lagrange's and Hamilton's equations of motion; special problems in vibrations and dynamics. Prerequisites: E.Mch. 12, Math. 44 or 431. *Mr. Davids*
522. **THEORY OF VIBRATIONS (3)** Mathematical theory of vibrating systems; damping phenomena; forced vibrations; analogy between mechanical and electrical vibrations; transverse and torsional oscillation of shafts; vibration of strings, beams, membranes, and plates. Prerequisites: E.Mch. 13, Math. 44 or 431. *Mr. Vierck*
523. **RELAXATION METHODS (3)** Relaxation methods compared to iteration and other numerical methods of analysis; application to elasticity, plasticity, stability, fluid flow, heat transfer, and related fields. Prerequisites: E.Mch. 13 or 111, Math. 44. *Mr. Vierck*
524. **MATHEMATICAL METHODS IN ENGINEERING (3-6)** Prerequisite: Math. 451 or E.E. 435 or M.E. 452. *Mr. Davids*
- Unit A (3)** Matrix and tensor analysis, finite differences, relaxation, perturbation, and other approximate methods in solution of various engineering problems.

## ENGINEERING MECHANICS

*Unit B (3)* Energy methods, potentials, application to torsion problems, nonlinear problems, analogies and dimensional analysis, Bessel and other special functions, harmonic analysis.

526. NONLINEAR MECHANICS (3) Integral curves, singular points, self-sustained oscillations, stability problems, Hill's and Van der Pol's equation, mechanical and electrical applications. Prerequisite: E.Mch. 522.

528. EXPERIMENTAL METHODS IN VIBRATIONS (3) Investigation of one or more degrees of freedom, free and forced mechanical vibrations, vibration properties of materials, vibration techniques in nondestructive testing. Prerequisite: E.Mch. 401 or 522. *Mr. Brennan*

529. ENGINEERING APPLICATIONS OF SONICS (3) Sound and ultrasound in engineering and science; principles, radiation, transducers, devices for sonic processing and testing. Prerequisite: Phys. 443.

530. SOLID STATE MECHANICS (3) Relation between solid state physics and mechanics; mechanical properties for static, fatigue, creep, and impact conditions; high temperature properties; applications. Prerequisite: E.Mch. 14. *Mr. Marin*

531. THEORY OF PLASTICITY AND APPLICATIONS (3) Yield condition; plastic stress-strain relations; theory of slip-line fields; applications to bending, torsion, axially symmetric bodies, metal processing. Prerequisite: E.Mch. 504 or 507. *Messrs. Hu and Marin*

533. DETERMINATION OF MECHANICAL PROPERTIES (3) Experimental methods for determining hardness, elastic constants, creep behavior, fatigue strength, plastic flow, and dynamic properties of metals. Prerequisite: E.Mch. 14 or 530. *Mr. Hu*

534. PHOTOELASTICITY (3) Analysis of polariscopes; isoclinics, isochromatics, and stress trajectories; two- and three-dimensional photoelastic methods; determination of principal stresses; model preparation. Prerequisite: E.Mch. 408 or 507. *Mr. Oppel*

540. MECHANICS OF CONTINUA (3) Unified mathematical treatment of elements of fluid mechanics and of elasticity and plasticity of solids. Prerequisite: Math. 44 or 431.

550. STUDIES IN ENGINEERING MECHANICS (1-6) Studies in any field of engineering mechanics.

## ENGLISH

ARTHUR O. LEWIS, JR., *in Charge of Graduate Programs*  
221 Sparks Building

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Professors Bowman, Condee, Cramer, Frank, Graves, Harris, Locklin, Major, Mead, Peck, Rubin, Sams, Sutherland, and Young; Associate Professors Bayard, Bressler, Lewis, and Reed; Assistant Professors Bauer, Jerman, and Morse; and Messrs. Meserole and Weintraub.



A student may specialize in English literature, American literature, philology, or rhetoric. It is preferred that an entering student present 24 credits in English, but 18 credits in English exclusive of survey and freshman courses will be accepted. If the student does not present 18 credits in English, he must make up the deficiency early in his graduate work.

ENGLISH COMPOSITION (E CMP)

- |                                                |                     |
|------------------------------------------------|---------------------|
| 404. PUBLIC OPINION AND WRITTEN PERSUASION (3) | <i>Mr. Graves</i>   |
| 408. ENGLISH GRAMMAR (3)                       | <i>Miss McElwee</i> |
| 418. THE WRITING OF LITERARY CRITICISM (3)     | <i>Mr. Bressler</i> |
| 442. CONTEMPORARY PROSE STYLE (3)              | <i>Mr. Major</i>    |

ENGLISH LITERATURE (E LIT)

- |                                                    |                       |
|----------------------------------------------------|-----------------------|
| 400. TEACHERS' COURSE IN LITERATURE (3)            |                       |
| 401. MAIN CURRENTS IN AMERICAN LITERATURE (3)      | <i>Mr. Sutherland</i> |
| 423. FORMS AND MOVEMENTS OF BRITISH LITERATURE (3) |                       |
| 439. OUR CONTEMPORARIES (3)                        |                       |
| 440. MASTERS OF BRITISH LITERATURE (3)             |                       |
| 441. MASTERS OF AMERICAN LITERATURE (3)            |                       |
| 464. SPENSER (3)                                   | <i>Miss Locklin</i>   |
| 466. MILTON (3)                                    | <i>Mr. Condee</i>     |
| 480. THE DRAMA BEFORE SHAKESPEARE (3)              |                       |
| 481. JACOBAN AND CAROLINE DRAMA (3)                | <i>Mr. Harris</i>     |
| 484. AMERICAN DRAMA (3)                            | <i>Mr. Rubin</i>      |
| 486. LATER BRITISH AND IRISH DRAMATISTS (3)        |                       |
| 487. MODERN CONTINENTAL DRAMA (3)                  |                       |
| 488. THE DRAMA FROM DRYDEN TO SHERIDAN (3)         | <i>Mr. Harris</i>     |

ENGLISH (ENGL)

- |                                                                           |                                                                                                                                                                                        |
|---------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 501. MATERIALS AND METHODS OF RESEARCH (3)                                | Bibliography of literary history and criticism; methods of editing and annotating texts; form and materials of dissertations. Required of all graduate students with an English major. |
| 502. CLASSICAL ORIGINS OF ENGLISH PROSE AND POETIC THEORIES (3)           | Rhetorical and poetic doctrine of ancient and medieval times. <i>Mr. Reed</i>                                                                                                          |
| 507. RESEARCH PROBLEMS IN ENGLISH (1-6)                                   | Methods of research in English, problems of bibliography, and method of evaluating sources and materials.                                                                              |
| 508. BEOWULF (3)                                                          | Reading of the text and study of the prominent literary problems and relationships.                                                                                                    |
| 509. NONDRAMATIC WRITERS OF THE ELIZABETHAN PERIOD: THE PROSE WRITERS (3) |                                                                                                                                                                                        |
| 510. NONDRAMATIC WRITERS OF THE ELIZABETHAN PERIOD: THE POETS (3)         | <i>Miss Locklin</i>                                                                                                                                                                    |
| 514. SHAKESPEARE (3)                                                      | Special problems in the works of Shakespeare. <i>Mr. Bowman</i>                                                                                                                        |
| 515. THE AGE OF SWIFT (3)                                                 | Special studies varying from year to year. <i>Mr. Harris</i>                                                                                                                           |

## ENGLISH

516. THE AGE OF JOHNSON (3) The work of Johnson and his circle.  
*Mr. Mead*
517. BYRON, SHELLEY, AND KEATS (3)
518. PRE-ROMANTIC WRITERS (3) Development of Romantic ideas in the 18th century.
519. WORDSWORTH, COLERIDGE, SOUTHEY, AND SCOTT (3)
530. HISTORY OF THE ENGLISH LANGUAGE (3) Germanic background of English, phonological and morphological developments, dialect differentiations, and principles of linguistic change.  
*Mr. Mead*
531. OLD ENGLISH (3) Old English language and literature with lectures on Old English and Germanic philology.
532. MIDDLE ENGLISH (3) Middle English language and literature with lectures on the development of Old English through Middle English to modern times.  
*Mr. Mead*
534. HISTORICAL ENGLISH GRAMMAR (3) Evolution of the grammatical system of English.  
*Mr. Peck*
535. RENAISSANCE AND MODERN RHETORIC (3) The rhetorical and poetic doctrine of Renaissance and modern times.  
*Mr. Bressler*
540. CHAUCER (3) Analysis of Chaucer's poetry in the light of its background, sources, and subsequent influences.  
*Mr. Mead*
542. PROSE STYLE (3) Development of English prose style.  
*Mr. Major*
543. CAVALIER AND ANGLICAN (3) Poetry and prose of the middle years of the 17th century from the death of Shakespeare to 1660.
544. RESTORATION LITERATURE (3) Selected studies of writers in England between 1650 and 1700.  
*Mr. Harris*
545. POETS OF THE VICTORIAN PERIOD, EXCLUSIVE OF TENNYSON AND BROWNING (3)
546. TENNYSON AND BROWNING (3)
547. PROSE WRITERS OF THE VICTORIAN PERIOD (3)
550. SELECTED STUDIES IN THE BRITISH NOVEL TO 1840 (3)  
*Mr. Bowman*
551. SELECTED STUDIES IN THE BRITISH NOVEL FROM 1840 TO THE PRESENT (3)  
*Mr. Sutherland*
562. THE AMERICAN NOVEL (3)
563. AMERICAN ESSAYS (3) Lectures and reports on a special group of essayists.
565. THE AMERICAN SHORT STORY (3)
566. AMERICAN POETRY (3)
567. ANGLO-AMERICAN FOLK SONG (3) Oral tradition of melodies and texts; types, regions, theories.  
*Mr. Bayard*

## ENTOMOLOGY

BERTIL G. ANDERSON

*Head of the Department of Zoology and Entomology*  
212 Frear Laboratory*Degrees Conferred:* Ph.D., M.S.*Graduate Faculty:* Professors E. J. Anderson, Blackburn, Cheng, Coon, Frings, and Tietz; Associate Professor Rutschky; Assistant Professors Boyle and Smyth.

A student majoring in entomology may specialize in apiculture, ecology, economic entomology, morphology, physiology, insect resistances of plants, taxonomy, or toxicology of insecticides.

For admission a student is required to have 24 credits in entomology or zoology and related biological sciences; and he should have had chemistry through organic chemistry. Courses in physics and mathematics are also advantageous. A limited deficiency may be made up, without degree credit, while pursuing graduate work.

## ENTOMOLOGY (ENT)

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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| 401. MEDICAL AND VETERINARY ENTOMOLOGY (3)                                                                                                                                                                                                                                        | <i>Mr. Frings</i>    |
| 403. SYSTEMATIC ENTOMOLOGY (3)                                                                                                                                                                                                                                                    | <i>Mr. Boyle</i>     |
| 405. INSECT MORPHOLOGY (3)                                                                                                                                                                                                                                                        | <i>Mr. Rutschky</i>  |
| 413. ENTOMOLOGY SEMINAR (1 per semester)                                                                                                                                                                                                                                          |                      |
| 429. PRINCIPLES OF INSECT CONTROL (3)                                                                                                                                                                                                                                             | <i>Mr. Blackburn</i> |
| 430. INSECT HISTOLOGY (2)                                                                                                                                                                                                                                                         | <i>Mr. Rutschky</i>  |
| 431. ENTOMOLOGICAL PROBLEMS (1-6)                                                                                                                                                                                                                                                 |                      |
| 445. THE IDENTIFICATION OF INSECTS (3)                                                                                                                                                                                                                                            |                      |
|                                                                                                                                                                                                                                                                                   |                      |
| 505. ADVANCED MORPHOLOGY OF INSECTS (3) Advanced work in either external or internal morphology of insects. Prerequisites: Ent. 403, 405. Spring semester, even years.                                                                                                            | <i>Mr. Rutschky</i>  |
| 506. IMMATURE INSECTS (3) The morphology and taxonomy of the immature stages of insects. Prerequisite: 9 credits in entomology. Spring semester, even years.                                                                                                                      | <i>Mr. Blackburn</i> |
| 508. THE BIOLOGICAL CONTROL OF INSECTS (2) Artificial use of bacteria, fungous diseases, and animals in control of injurious insects; methods and equipment for rearing parasites and predators on a large scale. Prerequisites: Ent. 6, 8, 407.                                  |                      |
| 509. ENTOMOLOGICAL TECHNIQUE (2) For advanced students dealing with special methods of collecting, rearing living insects, preparing and preserving immature stages, keeping records, and preparing illustrations for manuscript. Prerequisite: Ent. 6. Fall semester, odd years. | <i>Mr. Coon</i>      |
| 514. ADVANCED SYSTEMATIC ENTOMOLOGY (1-15 per semester) Taxonomy of various orders of insects selected to meet the needs of the individual student. Prerequisites: Ent. 403, 405.                                                                                                 | <i>Mr. Boyle</i>     |



## ENTOMOLOGY

528. INSECT PHYSIOLOGY (4) Normal functions of the insect body. Fall semester, even years. *Mr. Smyth*
531. INSECT TOXICOLOGY (2) General principles of toxicology and survey of the actions of substances toxic to insects. Spring semester, odd years. *Mr. Smyth*
540. INSECT RESISTANCE IN PLANTS (2) Mechanism, expression, permanence, and measurement of resistance to insects with special reference to farm crops. Spring semester, odd years. *Mr. Coon*

## FOODS and NUTRITION

MIRIAM E. LOWENBERG, *Head of the Department*  
202A Home Economics Building

*Degrees Conferred:* M.S. and M.Ed. in Foods; Ph.D., D.Ed., M.S., and M.Ed. in Nutrition; M.S. in Nutrition in Public Health (offered in co-operation with the University of Pittsburgh).

*Graduate Faculty:* Professors Dodds, Lowenberg, Padgett, and Wilson; Associate Professors Fisher, Fuqua, Olson, and Pike.

Graduate programs in foods and nutrition prepare students for careers in high school teaching, college teaching, research, and adult program leadership. The program in nutrition in public health prepares the student for work in public health agencies.

For admission to a graduate program in foods or nutrition, a student must have completed at least 9 credits in organic and inorganic chemistry, 3 in biological chemistry, 3 in bacteriology, 3 in psychology, 9 in social sciences, and 10 in foods and nutrition.

For admission to the program in nutrition in public health, the requirements are at least 9 credits in inorganic chemistry, 3 in biological chemistry, 3 in bacteriology, 10 in social sciences, 7 in foods, and 4 in nutrition.

### FOODS, NUTRITION, AND HEALTH (F N)

400. SPECIAL PROBLEMS IN FOODS AND NUTRITION (1-3)
420. EXPERIMENTAL COOKERY (1-6) *Miss Olson*
421. ADVANCED FOODS (3) *Miss Batjer*
422. SCIENTIFIC PRINCIPLES OF FOOD PREPARATION (3)
423. (H.M.F.E. 423). FAMILY FOOD PURCHASING (2)
425. FOOD PRESERVATION (2)
426. RECENT DEVELOPMENTS IN FOODS (3)
451. RECENT DEVELOPMENTS IN NUTRITION (3)
452. ELEMENTS OF DIET IN DISEASE (3) *Miss Pike*
455. TEACHING NUTRITION TO BOYS AND GIRLS (3)
456. NUTRITION IN THE COMMUNITY (3) *Miss Lowenberg*
457. PRINCIPLES OF NUTRITION (3)
458. APPLIED NUTRITION (2)

## FOODS AND NUTRITION

520. READINGS IN FOODS (2) Critical review and reports of literature on selected food topics.
521. SEMINAR IN FOODS (1-6) Discussion and reports on current research in the foods field. Prerequisite or concurrent: F.N. 520.
522. ADVANCED EXPERIMENTAL FOODS (3) Experimental methods used in measuring the quality of foods; specific problems in food preparation.
530. PROBLEMS IN FOODS AND NUTRITION (1-6)
531. ADVANCES IN FOODS AND NUTRITION (3) Recent findings in the related areas of foods and nutrition.
550. READINGS IN NUTRITION (3) Readings and reports of selected topics in nutrition. Prerequisite: F.N. 457.
551. SEMINAR IN NUTRITION (1-6) Selected topics and recent advances in nutrition.
552. DIET IN DISEASES (3) Physiological and biochemical problems in metabolic diseases and the nutritional aspects of therapy. *Miss Pike*
553. NUTRITION OF CHILDREN (3) Nutritional needs of the normal child during prenatal life, infancy, and childhood. Prerequisites: A.B.Ch. 35, F.N. 457.
555. FIELD WORK IN NUTRITION (2-4) Field problems planned to meet the needs of individual students. Hours and problems to be arranged.
556. THE SURVEY METHOD IN FOODS AND NUTRITION (2) Study of survey technique as a tool in the assay of food adequacy and nutritional status. *Miss Dodds*
557. INTERRELATIONSHIPS OF NUTRIENTS (2) Interrelationships of nutrients in the metabolic processes; their significance as applied to nutrition. *Miss Pike*

## FORESTRY

PETER W. FLETCHER  
*Director of the School of Forestry*  
102 Forestry Building

*Degrees Conferred:* M.S., M.F.

*Graduate Faculty:* Professors Fletcher, Goddard, Humphrey, McDermott, Norton, Sharp, and White; Associate Professors Bartoo, Chisman, and Nearn; Assistant Professor Jorgensen.

A student may specialize in forest management, silviculture, wildlife management, wood utilization, wood technology, or forest products.

A B.S. degree in forestry normally provides the minimum preparation for specialization in any of the above areas except wood utilization. A B.S. degree in wood utilization, or a similar program emphasizing mathematics and basic engineering courses, provides the minimum preparation for specialization in wood

## FORESTRY

utilization and is acceptable for advanced work in wood technology and forest products. Preparation for graduate work in wildlife management may be secured in any program which has emphasized land management and has included work in dendrology, silvics, forest measurement, and forest management.

Students with limited deficiencies may be admitted but must make up deficiencies without degree credit.

### FORESTRY (FOR)

421. REGIONAL SILVICULTURE (4)  
427. FOREST RANGE MANAGEMENT (3) *Mr. Chisman*  
445. IMPROVEMENTS (3)  
450. ADVANCED MENSURATION (3)  
455. FOREST PHOTO INTERPRETATION (3)  
466. FOREST MANAGEMENT AND MANAGEMENT PLANS (4)  
469. PROBLEMS IN FORESTRY (1-9)  
480. POLICY AND ADMINISTRATION (3)  
481. FOREST WATERSHED MANAGEMENT (3)  
491. LOGGING AND LUMBERING (3) *Mr. Schmidt*  
497. SMALL SAWMILLS (3) *Mr. Schmidt*
504. RESEARCH METHODS IN FORESTRY (2-6 per semester) Review of methods employed in conducting forestry research.
508. FOREST ECOLOGY (2-4) Organization, development, and classification of forest communities.
509. COVERT MANAGEMENT (2) Management of forest associations for maintenance and development of wildlife. Prerequisite: For. 508.
510. FORESTRY SEMINAR (1-2 per semester) Current problems of forest research presented as weekly seminar reports. May be repeated with additional credit for each semester's work.
550. FOREST MENSURATION (2-8 per semester) Research in some chosen field. Prerequisite: For. 450.
560. FOREST MANAGEMENT (3-8) Special topics in forest management and research in some chosen field. Prerequisite: For. 466.
575. APPLICATIONS OF FOREST ECONOMICS AND FINANCE (3 per semester) Survey of situations in forestry where business problems and particular circumstances of production, value, and costs are currently significant. Prerequisite: For. 70. *Mr. Humphrey*
590. THE LUMBER INDUSTRY (2-4) Relation of the lumber industry to national economy and world trade; lumbermen's associations; lumber accounts.
591. PROBLEMS IN LOGGING AND LUMBERING (2-6) Research in some chosen phase of lumbering. Prerequisite or concurrent: For. 590.

### WOOD UTILIZATION (W U)

404. MECHANICAL PROPERTIES OF WOOD (3) *Mr. Nearn*  
405. VENEER AND PLYWOOD (3) *Messrs. Jorgensen and Nearn*



## WOOD UTILIZATION

431. PROBLEMS IN FOREST PRODUCTS (3-6) *Messrs. Norton and Nearn*  
435. SEASONING AND PRESERVATION (3) *Mr. Nearn*  
437. ADVANCED WOOD TECHNOLOGY (3) *Messrs. White and Jorgensen*  
462. DEFECTS IN WOOD (3) *Mr. Norton*  
492. LUMBER DISTRIBUTION (3) *Mr. Schmidt*  
495. MILLING AND COSTS IN THE FOREST PRODUCTS INDUSTRIES (3) *Mr. Schmidt*
502. WOOD FIBERS (3-5) Identification and physical and chemical characteristics of wood fibers used for pulp, either for paper or as a source of cellulose. Pulp quality, fiber measurements. *Mr. White*
510. WOOD UTILIZATION SEMINAR (1-2 per semester)
530. PROBLEMS IN WOOD UTILIZATION (3-6 per semester) Prerequisite: W.U. 431. *Mr. Norton*
531. STRUCTURAL USES OF WOOD AND WOOD PRODUCTS (3-6 per semester) Wood as a construction material; testing techniques for structural timbers and wood assemblies; use of laminated wood, ring connectors, and other types of special construction. Prerequisite: W.U. 404. *Mr. Norton*
532. LAMINATES (3-6 per semester) Advanced and special studies in fabrication and use of plywood, laminated wood, paper-base laminates, and wood-to-metal bonding. Prerequisite: W.U. 405. *Mr. Norton*
535. CONDITIONING TREATMENTS FOR WOOD (3-6 per semester) Advanced study and problems in preservative, seasoning, and other special treatments for wood and wood products. Prerequisite: W.U. 435. *Mr. Norton*

## FUEL TECHNOLOGY

HOWARD B. PALMER, *Head of the Department*  
212 Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Kinney, Spicer, and Walker; Associate Professor Palmer; Assistant Professors Polansky and Vastola.

The graduate program includes the chemistry and combustion of solid, liquid, and gaseous fuels. There is opportunity for research in the chemistry of coals and carbons and in the combustion of fuels.

A bachelor's degree with undergraduate training in one of the following fields is necessary for admission: chemistry, chemical engineering, physics, or fuel technology.

### FUEL TECHNOLOGY (F T)

400. FUEL TECHNOLOGY RESEARCH AND DESIGN (1-3)  
401. FUEL GASES AND GASIFICATION (2) *Mr. Austin*

## FUEL TECHNOLOGY

402. CHEMICALS FROM FUELS (2) Mr. Kinney  
405. COMBUSTION CALCULATIONS (3) Mr. Austin  
406. GASEOUS COMBUSTION (3) Mr. Palmer  
408. COMBUSTION TECHNOLOGY (4) Mr. Spicer  
409. THERMAL PROCESSING OF FUELS (2) Mr. Polansky  
410. THERMAL PROCESSING LABORATORY (2)  
411. JET AND ROCKET FUELS (2) Mr. Palmer  
412. CATALYTIC PROCESSES IN THE FUEL INDUSTRIES (2) Mr. Walker
503. CHEMICAL CONSTITUTION AND SCIENTIFIC CLASSIFICATION OF COAL (3-6)  
Chemistry of plant constituents in relation to coal and the coalification process; constitution of coal as deduced by chemical methods; scientific classification of coals. Prerequisite: Chem. 31. Mr. Kinney
506. ADVANCED SOLIDS COMBUSTION (3) Current approaches to heterogeneous reactions in combustion and gasification of coals and carbons. Prerequisite: Chem. 461. Mr. Walker
507. ADVANCED THERMAL PROCESSING (3) Pyrolysis, coal carbonization, coke manufacture and uses; action of heat on coals and fuels; technical and economic factors. Prerequisites: Chem. 35, 461, or Mn.Pr. 410. Mr. Polansky
509. TECHNOLOGY OF TARS (3) Formation, constitution, physical and chemical properties of coal, oil-gas and water-gas tar; processing and utilization. Prerequisite: Chem. 31. Mr. Polansky
510. FUEL TECHNOLOGY PROBLEM (1-6 per semester) Special problems in fuel technology. Prerequisite: F.T. 503.
511. FUEL TECHNOLOGY SEMINAR (1-6) Selected topics from current fuel technology research examined and discussed. Prerequisite: Chem. 35 or 461. Mr. Kinney and Staff
512. ADVANCED GASEOUS COMBUSTION (3) Theories of reaction mechanisms; measurement of gaseous combustion parameters; review of current literature. Prerequisite: F.T. 406. Mr. Palmer
- NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in fuel technology studies are listed under Mineral Sciences in Part II of this bulletin.*

## GENETICS AND BREEDING

JAMES E. WRIGHT, *Chairman of the Committee on Genetics and Breeding*  
307 Buckhout Laboratory

*Degrees Conferred:* Ph.D., M.S.

Graduate programs are offered in the fields of theoretical and applied genetics. Courses in genetics and breeding are given by various departments. The basic and theoretical courses are listed under identical numbers in the Department of Botany and Plant Pathology and the Department of Zoology and Entomology. Courses dealing with genetic principles as applied to specific organisms are offered

## GENETICS AND BREEDING

in the Departments of Agronomy, Animal Husbandry, Bacteriology, Horticulture, and Poultry Husbandry. The graduate committee for majors shall be appropriately represented by members of theoretical and applied phases who shall have the responsibility and jurisdiction for determining course work and research acceptable in satisfying degree requirements.

For entry as a major in this field no fewer than 15 credits in basic biology and 15 credits in the areas of chemistry, mathematics, and physics are required.

The following courses are available in genetics and breeding, and their descriptions may be found under the offerings of the several departments: Agro. 411, 509, 510, 582; A.H. 501, 505; Bact. 516; Bot. (Zool.) 405, 422, 505, 524, 528, 533; Hort. 444, 503, 519, 520; P.H. 412.

## GEOCHEMISTRY and GEOPHYSICS

B. F. HOWELL, JR., *Head of the Department of Geophysics and Geochemistry*  
220 Mineral Sciences Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Bell, Howell, Keith, Osborn, Roy, and Tuttle; Assistant Professors Burnham, Crowe, Herzog, and Wyllie; Mrs. Roy.

Graduate work is offered in the field of geophysics (geophysical prospecting, seismology, gravity, well logging, radioactive age determinations, tectonics) and in the field of geochemistry (crystal chemistry, phase equilibria, element distribution and affiliations, isotope geochemistry, geochemical prospecting, cosmochemistry, high temperature and high pressure geochemistry).

Before starting graduate study an applicant is generally expected to have had (1) a standard introductory course in each of the following four subjects: chemistry, physics, geology, and mineralogy; (2) 12 semester hours of intermediate level work in any one or a combination of chemistry, physics, and geological science; and (3) mathematics through integral calculus (for geochemistry) or differential equations (for geophysics). Students who have taken somewhat less than the indicated minima in these subjects may be admitted, but must make up their deficiencies concurrently with their graduate studies.

### GEOPHYSICS AND GEOCHEMISTRY (G G)

- |                                                                                                             |                          |
|-------------------------------------------------------------------------------------------------------------|--------------------------|
| 401. ELECTRICAL PROSPECTING (3)                                                                             | Mr. Crowe                |
| 402. SEISMIC PROSPECTING (3)                                                                                | Mr. Howell               |
| 403. GEOPHYSICS FIELD WORK (1-3)                                                                            | Messrs. Crowe and Howell |
| 405. INTRODUCTORY GEOPHYSICS (3)                                                                            | Mr. Howell               |
| 406. INTRODUCTORY GEOCHEMISTRY (3)                                                                          | Mr. Keith                |
| 407. WELL LOGGING (3)                                                                                       | Mr. Crowe                |
| 408. POTENTIAL THEORY APPLIED TO EARTH PROBLEMS (3)                                                         | Mr. Crowe                |
| 409. GEOPHYSICAL PROSPECTING (3)                                                                            | Mr. Crowe                |
| 500. GEOPHYSICAL SEMINAR (1 per semester) Discussion of geophysical reports and papers; scientific outlook. |                          |



## GEOCHEMISTRY AND GEOPHYSICS

501. RESEARCH (1-15 per semester) Original research in geophysics or geochemistry.
502. SEISMIC INSTRUMENTS (3) Characteristics and design of seismometers and seismic recorders. Prerequisite: Phys. 285, differential equations. Given alternate years. *Mr. Howell*
503. SPECIAL STUDIES IN GEOPHYSICS (1-9) Special studies of the theories of geophysical methods.
507. SEISMOLOGY (3) Nature and transmission of seismic waves; cause and occurrence of earthquakes; applications in seismic prospecting. *Mr. Howell*
508. TECTONICS (3) Seminar in the cause and nature of the principal deformations of the earth. *Mr. Howell*
509. GEOCHEMISTRY SEMINAR (1 per semester)
510. PROBLEMS IN GEOCHEMISTRY (1-9) Laboratory and library study of special problems.
512. INTRODUCTION TO HIGH-TEMPERATURE GEOCHEMISTRY (3) Ion configuration and radii; simple crystal structures; measurement and control of temperature and pressure; methods and principles of phase equilibrium determination. *Messrs. Roy and Osborn*
513. PHASE EQUILIBRIA IN MINERAL SYSTEMS (3-6) Phase relations and constitution of inorganic crystals and liquids; special emphasis on systems closely related to natural magmas and rock systems. Prerequisite: G.G. 512. *Messrs. Osborn, Tuttle, and Roy*
514. ELEMENT DISTRIBUTION IN THE EARTH (3) Principles and data from studies of phase equilibria, petrology, and crystal structure as related to distribution of elements in minerals, rocks, and the earth. *Mr. Burnham*
515. ELECTRIC WELL-LOGGING (2-3) Quantitative and qualitative methods of interpreting electric resistivity, induction, and self-potential logs; comparison of electrical logging methods.
516. NUCLEAR GEOPHYSICS (3) Natural radioactivity and its measurement, spectroscopy, age determinations, geothermometry, radioactive prospecting and logging. *Mr. Herzog*

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in geophysical and geochemical studies are listed under Mineral Sciences in Part II of this bulletin.*

## GEOGRAPHY

E. WILLARD MILLER, *Head of the Department*  
202 Mineral Sciences Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Deasy and Miller; Associate Professors Griess, Rodgers, and Wernstedt.

Students may concentrate on physical geography, human geography, political geography, economic geography, cartography, or some aspect of regional geography.

Because physical geography is a branch of the physical sciences and human, political, and economic geography are branches of the social sciences, a student may enter graduate work under either of two options. Option 1, for the student who wishes to specialize in physical geography, requires the completion of 18 undergraduate credits in geography and 20 credits in mathematics and biological and physical sciences, including at least 6 credits in geology. Option 2, for the student who wishes to specialize in human, political, or economic geography, requires 18 undergraduate credits in geography plus 20 credits in the social sciences, including at least 3 in economics.

## GEOGRAPHY (GEOG)

- |                                                 |                      |
|-------------------------------------------------|----------------------|
| 400. REGIONAL GEOGRAPHY OF NORTH AMERICA (3)    | <i>Mr. Deasy</i>     |
| 405. GEOGRAPHY OF POPULATION AND SETTLEMENT (3) |                      |
| 420. URBAN GEOGRAPHY (3)                        | <i>Mr. Rodgers</i>   |
| 427. REGIONAL GEOGRAPHY OF THE SOVIET UNION (3) | <i>Mr. Rodgers</i>   |
| 433. REGIONAL CLIMATOLOGY (3)                   | <i>Mr. Wernstedt</i> |
| 442. GEOGRAPHY OF EUROPE (3)                    | <i>Mr. Miller</i>    |
| 443. GEOGRAPHY OF THE ORIENT (3)                | <i>Mr. Wernstedt</i> |
| 444. GEOGRAPHY OF AFRICA (3)                    | <i>Mr. Smith</i>     |
| 452. INTERPRETATION OF AERIAL PHOTOGRAPHS (3)   | <i>Mr. Deasy</i>     |
| 460. POLITICAL GEOGRAPHY (3)                    | <i>Mr. Lewis</i>     |
| 480. GEOGRAPHY OF WORLD MANUFACTURING (3)       | <i>Mr. Miller</i>    |
| 490. PHYSICAL GEOGRAPHY FOR TEACHERS (3)        | <i>Mr. Lewis</i>     |
503. ADVANCED REGIONAL GEOGRAPHY (3-12) Intensive study at an advanced level of selected regions or sections of the continents. Prerequisite: 12 credits in geography.
504. PHYSICAL GEOGRAPHY SEMINAR (3-12) The literature of some phase of physical geography with emphasis on procedures for organizing material for classroom reports and discussions.
505. ECONOMIC GEOGRAPHY SEMINAR (3-12) The literature of some phase of economic geography with emphasis on procedures for organizing material for classroom reports and discussions.
506. CULTURAL AND POLITICAL GEOGRAPHY SEMINAR (3-12) The literature of some phase of cultural and political geography with emphasis on procedures for organizing material for classroom reports and discussions.
507. DEVELOPMENT OF GEOGRAPHIC THOUGHT (1-6) Critical analysis of the growth of geographic thought from antiquity to the present; emphasis on structure of modern geography.
510. PHYSICAL GEOGRAPHY RESEARCH (3-10) Original study in physical geography: a field problem or detailed library investigation with analysis and presentation of data.
511. ECONOMIC GEOGRAPHY RESEARCH (3-10) Original study in economic geography: a field problem or detailed library investigation with analysis and presentation of data.
512. CULTURAL AND POLITICAL GEOGRAPHY RESEARCH (3-10) Original study in cultural and political geography: a field problem or detailed library investigation with analysis and presentation of data.

## GEOLOGY

FRANK M. SWARTZ, *Head of the Department*  
110 Mineral Sciences Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Krynine, Ridge, and Swartz; Associate Professors Scholten and Spackman; Assistant Professors Lattman, Schmalz, and Williams.

Graduate work in this field offers opportunity for specialization in stratigraphy, paleontology, paleobotany, palynology, regional and structural geology, geomorphology, coal geology, and metalliferous geology.

Prerequisites for admission include 25 credits in an approved combination of chemistry, physics, mathematics, and biological sciences, and at least 18 credits in geology and mineralogy.

## GEOLOGY (GEOL)

- |                                        |              |
|----------------------------------------|--------------|
| 400. GEOLOGY FOR TEACHERS (3)          |              |
| 420. PALEOBOTANY (3)                   | Mr. Spackman |
| 424. GEOLOGY OF COAL (2)               | Mr. Williams |
| 426. INTRODUCTORY PALYNOLOGY (2)       |              |
| 440. MARINE GEOLOGY (3)                | Mr. Schmalz  |
| 451. ECONOMIC GEOLOGY (3)              | Mr. Ridge    |
| 455. PHYSIOGRAPHY OF NORTH AMERICA (3) |              |
| 461. GEOLOGY OF THE UNITED STATES (3)  |              |
| 462. PRINCIPLES OF GEOMORPHOLOGY (3-6) | Mr. Lattman  |
| 464. PALEONTOLOGY (3)                  | Mr. Swartz   |
| 481. GEOLOGY OF OIL AND GAS (3)        | Mr. Scholten |
| 483. STRUCTURAL GEOLOGY (3)            |              |
| 484. PALEOZOIC STRATIGRAPHY (3)        | Mr. Swartz   |
| 486. STRATIGRAPHIC METHODS (1)         | Mr. Swartz   |

\*500. GEOLOGY SEMINAR (1-9) Presentation, at weekly departmental meetings, of topics selected from geological literature.

†501. STRATIGRAPHY (3-12) Principles of stratigraphic classification, lithofacies and biofacies, faunal zonation, correlation, sedimentation, and paleogeography, illustrated by stratigraphy of classical geologic regions: (a) Pre-Cambrian; (b) Paleozoic; (c) Mesozoic; (d) Cenozoic. Prerequisite: Geol. 464.

Mr. Swartz

†503. PALEONTOLOGY (3-9) Morphology of animal groups significant for their fossils; nature of species and faunal zones. Seminars may be arranged for studies of special fossil groups, microfossils, paleoecology.

Mr. Swartz

504. HISTORY OF GEOLOGY (2-3) Development through the ages of the scientific method in earth sciences. Fall semester, odd years.

Mr. Krynine

507. SEMINAR IN GEOMORPHOLOGY (3-6) Classic and current literature in geomorphology.

Mr. Lattman

\*Credits to be arranged, 1 to 6 per semester.

†Credits to be arranged, 3 to 6 per semester.



511. ORE DEPOSITS: PRINCIPLES (3-6) Geological and geochemical processes controlling ore deposition; genetic classification of ore deposits. Prerequisite: Geol. 451. *Mr. Ridge*
512. ORE DEPOSITS: TYPES (1-6) Geologic history and field examination of selected ore bodies; forming media; causes, sequences, and loci of emplacement; wall rock alteration; secondary enrichment. Prerequisite: Geol. 511. *Mr. Ridge*
515. ORE MICROSCOPY (2-3) Theory and use of the ore microscope in identifying ore minerals in polished section, establishing paragenetic sequences, determining manner of deposition.
520. SEMINAR IN PALEOBOTANY (2-6) Current and classic literature concerning evolution, paleoecology, and geologic history of vascular plants. *Mr. Spackman*
524. COAL PETROLOGY (1-6) Microscopy, source materials, coalification, constitution, classification of peats, lignites, bituminous coal, anthracite. *Mr. Spackman*
526. PROBLEMS IN PALYNOLOGY (3-9) Systematics; paleoecological palynology; Paleozoic palynology; Mesozoic and Cenozoic palynology; Pleistocene vegetational history.
530. GEOLOGICAL PROBLEMS (3-6) Study, from the literature, of a selected geological problem. Prerequisite: 10 credits in geology and mineralogy.
540. CHEMICAL OCEANOGRAPHY (3) Chemical reactions in sea water and at the sea floor related to sedimentation and diagenesis. *Mr. Schmalz*
545. GLACIAL GEOLOGY (3) Glaciers: their characteristics, causes, deposits, land forms, effects in periglacial regions. *Mr. Lattman*
546. PRINCIPLES OF PHOTOGEOLOGY (3) Use of aerial photographs and mosaics in structural, geomorphic, and rock distribution studies and in compilation of maps. Prerequisites: Geol. 462, 483. *Mr. Lattman*
551. GEOTECTONICS (3-6) Tectonic principles and elements: nature and development of geosynclines, island arcs, mountain structures, stable masses, cratons, mobile belts. *Mr. Scholten*
555. ADVANCED STRUCTURE AND PETROFABRICS (1-3) Macroscopic and microscopic recognition, measurement, and interpretation of small-scale rock structures and mineral orientation patterns in deformed rocks.
571. PETROLEUM PROVINCES OF THE WORLD (3) Stratigraphy, structure, geologic history, and oil and gas occurrence in major petroliferous provinces. *Mr. Scholten*
590. GEOLOGY FIELD TRIP (1 per year) Field study of regional geologic features with trips in successive years to differing geologic provinces. Required each spring of all graduate students in geology.

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in geological studies are listed under Mineral Sciences in Part II of this bulletin.

# GERMAN

PHILIP A. SHELLEY, *Head of the Department*  
229 Sparks Building

*Degrees Conferred:* Ph.D., M.A., M.Ed.

*Graduate Faculty:* Professors Adolf, Buffington, and Shelley; Associate Professors de Levie and Striedieck; Assistant Professor Browne.

There is opportunity for major emphasis upon either literature or philology. Minimum qualifications for admission include 18 undergraduate credits in German; provision is made, however, for admission with limited deficiencies.

## GERMAN (GER)

400. PROSEMINAR IN BIBLIOGRAPHY AND METHODS OF RESEARCH (2) *Mr. Shelley*
401. HISTORY OF THE GERMAN LANGUAGE (3) *Mr. Buffington*
402. MIDDLE HIGH GERMAN (3) *Mr. Buffington*
420. GERMAN LITERATURE TO 1700 (3) *Miss Adolf*
421. GERMAN LITERATURE IN THE 18TH CENTURY (3)  
*Messrs. Buffington and de Levie*
422. GERMAN LITERATURE IN THE 19TH CENTURY (3) *Miss Adolf*
423. GERMAN LITERATURE OF THE 20TH CENTURY (3)
424. GOETHE'S LIFE AND WORKS (3) *Messrs. Buffington and de Levie*
426. SCHILLER'S LIFE AND WORKS (3)
443. (C.Lit. 443). LITERARY RELATIONS OF GERMANY WITH ENGLAND AND AMERICA (3-9) *Mr. Shelley*
- \*1G. ELEMENTARY GERMAN FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.
- \*2G. ELEMENTARY GERMAN FOR GRADUATE STUDENTS (3) Continuation of Ger. 1G, with opportunity for reading in special fields.
501. GERMAN LANGUAGE SEMINAR (3-12) Critical study of special problems in the Germanic languages, with emphasis on Gothic and the High German dialects in different eras.
515. GERMAN LITERATURE SEMINAR (3-12) Special aspects and characteristics of individual writers and various types and periods of literature.
531. SPECIAL STUDIES IN THE GERMAN LYRIC (3) *Mr. Shelley*
532. SPECIAL STUDIES IN THE GERMAN DRAMA (3) *Miss Adolf*
533. SPECIAL STUDIES IN THE GERMAN SHORT STORY (3)
534. SPECIAL STUDIES IN THE GERMAN NOVEL (3) *Miss Adolf*
552. OLD HIGH GERMAN (3) Essentials of the grammar, with special treatment of the High German sound shift and of ablaut and umlaut. Reading of works written before 1100 A.D. *Mr. Buffington*
553. GOTHIC (3) Essentials of the grammar; reading of Ulfilas' Bible translation. Suitable also for advanced students in English. *Miss Adolf*

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\*No graduate credit is given for this course.

## HIGHER EDUCATION

HUGH S. BROWN, *in Charge of Graduate Programs in Higher Education*

*Degree Conferred:* D.Ed.

*Graduate Faculty:* Professors Brown and Patrick

Graduate students with any undergraduate major may enter the program without other prerequisites. The following courses in higher education are listed under the offerings of the Department of Educational Services: Ed.Ser. 545 to 552 inclusive and 555 (See page 91). To complete a program to meet the student's needs, additional courses will be selected from other departments of the University.

Candidates for advanced degrees in other fields may elect higher education as a minor, subject to the restrictions concerning minors.

## HISTORY

ROBERT K. MURRAY, *Head of the Department*  
116 Sparks Building

*Degrees Conferred:* Ph.D., D.Ed., M.A., M.Ed.

*Graduate Faculty:* Professors Dahmus, Forster, Gray, Klein, Pundt, and Rayback; Associate Professors Brown, DeNovo, McNall, Murray, and Thaden; Assistant Professors Green, Hassler, Pixton, and Spence.

Graduate work is offered in the following fields of history: ancient, medieval, early modern European, modern European, colonial American, 19th century American, modern American, British, Russian, Latin American, Far Eastern, political (European or American), economic (European or American); diplomatic (European or American), social and cultural (European or American).

For a master's degree the candidate must pass examinations in two of the first seven of the above fields. A candidate for a master's degree must also take work in a cognate field. For the doctorate, a candidate must pass examinations in four of the above fields, one of which must be his thesis field. He also must pass an examination either in another of the above history fields and a single cognate field, or in a study area made up of a number of academic disciplines related to his thesis field.

The entering student should present evidence of undergraduate course work covering the history of Europe from ancient times to the present and the history of America from its discovery to the present.

### HISTORY (HIST)

- |                                                               |            |
|---------------------------------------------------------------|------------|
| 401. ANCIENT CIVILIZATION (3)                                 | Mr. Kagan  |
| 403. THE MIDDLE AGES FROM CONSTANTINE TO THE CRUSADES (3)     | Mr. Dahmus |
| 404. THE MIDDLE AGES FROM THE CRUSADES TO THE RENAISSANCE (3) | Mr. Dahmus |
| 408. INTELLECTUAL HISTORY OF THE MIDDLE AGES (2-3)            | Mr. Dahmus |
| 410. RENAISSANCE AND REFORMATION (3)                          | Mr. Green  |



## HISTORY

- |      |                                                                    |                          |
|------|--------------------------------------------------------------------|--------------------------|
| 413. | THE AGE OF ABSOLUTISM (3)                                          | Mr. Green                |
| 417. | NINETEENTH CENTURY EUROPE (3)                                      | Mr. Forster              |
| 419. | RECENT EUROPEAN HISTORY (3)                                        | Mr. Forster              |
| 420. | COLONIAL AMERICA, 1607-1750 (3)                                    |                          |
| 422. | HISTORY OF THE AMERICAN FRONTIER (3)                               | Mr. Spence               |
| 424. | AMERICAN POLITICAL BIOGRAPHY (3)                                   | Messrs. Klein and Murray |
| 425. | HISTORICAL BACKGROUND OF AMERICAN POLITICAL PARTIES, 1607-1900 (3) | Mr. Rayback              |
| 427. | THE DIPLOMATIC HISTORY OF THE UNITED STATES (3)                    | Mr. DeNovo               |
| 428. | AMERICAN MILITARY HISTORY (3)                                      | Mr. Hassler              |
| 431. | THE AMERICAN REVOLUTION, 1751-1783 (3)                             |                          |
| 432. | THE FORMATIVE PERIOD OF AMERICAN HISTORY (3)                       | Mr. Klein                |
| 436. | RECENT AMERICAN HISTORY (3)                                        | Mr. Murray               |
| 440. | HISTORY OF ENGLAND AND GREAT BRITAIN SINCE 1485 (3)                | Mr. Ralls                |
| 442. | HISTORY OF RUSSIA TO 1861 (3)                                      | Mr. Thaden               |
| 443. | HISTORY OF MODERN RUSSIA (3)                                       | Mr. Thaden               |
| 444. | EASTERN EUROPE IN MODERN TIMES (3)                                 | Mr. Thaden               |
| 447. | ECONOMIC DEVELOPMENT OF MODERN EUROPE (3)                          | Mr. Pundt                |
| 448. | SOCIAL AND CULTURAL HISTORY OF MODERN EUROPE (3)                   | Mr. Pundt                |
| 452. | SOCIAL AND CULTURAL HISTORY OF THE UNITED STATES SINCE 1783 (3)    | Mr. Brown                |
| 454. | ECONOMIC DEVELOPMENT OF THE UNITED STATES (3)                      | Mr. McNall               |
| 456. | HISTORY OF AMERICAN LABOR (3)                                      | Mr. Rayback              |
| 460. | LATIN AMERICA AND THE UNITED STATES (3)                            | Mr. Gray                 |
| 461. | SOCIAL AND CULTURAL HISTORY OF LATIN AMERICA (3)                   | Mr. Gray                 |
| 471. | HISTORY OF MODERN CHINA (3)                                        |                          |
| 481. | THE MIDDLE EAST IN MODERN TIMES (3)                                | Mr. DeNovo               |
| 499. | FOREIGN STUDY IN HISTORY (2-6)                                     |                          |
| 501. | EUROPEAN HISTORIOGRAPHY (3)                                        | Mr. Pundt                |
| 502. | AMERICAN HISTORIOGRAPHY (3)                                        | Mr. Klein                |
| 504. | MEDIEVAL CIVILIZATION (3-9)                                        | Mr. Dahmus               |
| 505. | THE AGE OF THE REFORMATION (3-6)                                   | Mr. Green                |
| 508. | STUDIES IN EUROPEAN HISTORY, 1600-1789 (3-6)                       | Mr. Pundt                |
| 509. | EUROPE SINCE 1789 (3-6)                                            | Mr. Forster              |
| 512. | STUDIES IN PENNSYLVANIA HISTORY (3-6)                              | Mr. Klein                |
| 520. | COLONIAL AND REVOLUTIONARY AMERICA (3-6)                           |                          |
| 533. | THE UNITED STATES, 1783-1860 (3-6)                                 | Mr. Klein                |
| 534. | THE UNITED STATES, 1860-1900 (3-6)                                 | Mr. Brown                |
| 536. | THE UNITED STATES IN THE 20TH CENTURY (3-6)                        | Mr. Murray               |
| 538. | DIPLOMATIC HISTORY OF THE UNITED STATES (3)                        | Messrs. Gray and DeNovo  |
| 539. | ECONOMIC HISTORY OF THE UNITED STATES (3)                          | Mr. McNall               |
| 540. | STUDIES IN BRITISH HISTORY (3-6)                                   |                          |

545. STUDIES IN RUSSIAN AND SLAVIC HISTORY (3-6)
550. PROBLEMS IN HISTORY (3-6)
562. SEMINAR IN LATIN-AMERICAN HISTORY (3-6) *Mr. Gray*
563. STUDIES IN THE HISTORY OF THE CARIBBEAN AREA (3) Prerequisites:  
Hist. 22, 23. *Mr. Gray*
599. READINGS IN HISTORY (3)

## HOME ART

JAMES E. MONTGOMERY, *Professor of Housing and Home Art*  
219 Home Economics Building

No advanced degree is offered in this field, but a candidate with a major in another field may choose a minor in home art upon approval by his major department.

### HOME ART (H ART)

400. SPECIAL PROBLEMS IN HOME FURNISHINGS (3)
433. ADVANCED HOME CRAFTS (2-12)
440. HOME FURNISHING PROBLEMS (3)
444. HOME FURNISHING TEACHING PROBLEMS (3)
447. HOME FURNISHINGS FOR THE FAMILY (3)
515. BACKGROUNDS OF THE HOME ARTS (3) Evaluation of useful objects in respect to their form, function, and time; selections for exhibition. Prerequisites: H.Art 216 or Art 15 or A.Ed. 6, and A.A.H. 1 or H.Art 240.
530. PROBLEMS IN HOME ART (1-6) Individual investigation, analysis, and presentation. Prerequisite: 6 credits in home art, art education, or art.
541. ART IN THE ENVIRONMENT (3) Approach based upon human needs with consideration of materials in the light of their use in home living. Prerequisite: Art 14 or A.Ed. 5 or H.Art 440.

## HOME ECONOMICS EDUCATION

MARJORIE EAST, *Head of the Department*  
119C Home Economics Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors East and Hatcher; Associate Professor Hillier.

Research and graduate courses may be chosen to give emphasis to special areas of interest in home economics education, such as curriculum development; evaluation; teaching at the elementary, secondary, adult, or higher education levels; supervision; administration in colleges; or research.

## HOME ECONOMICS EDUCATION

For admission the student must present approximately 50 semester hours of undergraduate work from the following areas: home economics education, education and/or psychology, aspects of home economics; the physical and biological sciences; and the social sciences.

### HOME ECONOMICS EDUCATION (HE ED)

- 406, 406v. TEACHING AIDS IN FAMILY LIFE EDUCATION (1-4)  
427, 427v. FAMILY LIFE EDUCATION (3)  
443, 443v. ADULT HOMEMAKING EDUCATION (3)  
463, 463v. SENIOR SEMINAR (1)  
\*466, 466v. STUDENT TEACHING (9)  
478, 478v. APPRAISING STUDENT PROGRESS IN EDUCATION FOR FAMILY LIVING (3)  
479, 479v. READINGS IN HOME ECONOMICS EDUCATION (1-4)
- 502, 502v. HOME ECONOMICS INSTRUCTION AT THE COLLEGE LEVEL (3)  
Teaching techniques suitable for college instruction in home economics; for prospective home economics college teachers not majoring in home economics education.
- 503, 503v. PROBLEMS IN HOME ECONOMICS TEACHER EDUCATION (3) Organization of college programs of teacher education; use of resources; records; field services; recruitment and selection of personnel. Prerequisite: at least two years of experience in teaching home economics.
- 504, 504v. CURRENT DEVELOPMENTS IN EDUCATION IN RELATION TO HOME ECONOMICS (3) Opportunity for home economists to study newer developments in education. Prerequisite: one year of teaching experience in home economics. *Mrs. East*
- 505, 505v. PRACTICUM IN TEACHING HOME ECONOMICS IN THE SECONDARY SCHOOL (3-6) Projects in home economics education which may be carried out in the school in which the teacher is regularly employed.
- 509, 509v. CURRICULUM WORKSHOP IN FAMILY LIFE EDUCATION (3) Laboratory course in problems of curriculum building; individual problems in this field; frequent individual and group conferences. Prerequisite: one year's experience in teaching home economics. *Mrs. East or Miss Hatcher*
- 510, 510v. THE SUPERVISION OF HOME ECONOMICS TEACHING (2-6) For teachers of home economics desiring to qualify as city, county, or student teacher supervisors. Prerequisite: graduation from a four-year teacher education curriculum and two years' teaching experience in home economics. *Mrs. East*
- 518, 518v. EVALUATION IN FAMILY LIFE EDUCATION (3) Methods of evaluating progress toward goals in home economics education and use of findings in program planning and revision. *Mrs. East or Miss Hatcher*
- 521, 521v. HOME ECONOMICS EDUCATION SEMINAR (2-3) Selected topics and recent developments in education for family living. Conferences and guidance relative to individual research problems. *Mrs. East or Miss Hatcher*

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\*A grade point average of 2.2 in all previous work is prerequisite to each course in student teaching.



## HOME ECONOMICS EDUCATION

- 526, 526v. THE COMMUNITY PROGRAM IN FAMILY LIFE EDUCATION (2-3)  
Ways of discovering community needs and resources; methods of developing the community program in family living; leadership education for the lay member of the community.
- 530, 530v. PROBLEMS IN HOME ECONOMICS EDUCATION (1-6 per semester)  
Individual investigation of problems related to the teaching, supervision, or administration of home economics education.

### HOME ECONOMICS, GENERAL

DOROTHY HOUGHTON, *Professor of Home Economics*  
103 Home Economics Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

The program in General Home Economics is planned for teachers in secondary schools or small colleges and others who wish to be proficient in several areas of home economics. Consequently, the student must have a strong home economics background for admission to the major.

The major for the M.S. or M.Ed. degree consists of a minimum of 6 credits in each of three areas of home economics. Three areas of home economics are also the basis for the major at the doctoral level. However, the minimum credit requirements in each area are established after consultation with a committee which reviews all previous work. The student chooses a minor field of basic education or one of the applied fields, such as home economics education, secondary education, or higher education.

#### GENERAL HOME ECONOMICS (G H E)

- 516, 516v. METHODS OF RESEARCH IN HOME ECONOMICS (3) Review of problems and techniques of research in home economics. Required of all graduate students in home economics.
530. SELECTED PROBLEMS IN GENERAL HOME ECONOMICS (1-6)

### HOME MANAGEMENT AND FAMILY ECONOMICS

DELPHA E. WIESENDANGER  
*Head of the Department of Home Management, Housing, and Home Art*  
109A Home Economics Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.  
*Graduate Faculty:* Professors Britton, Montgomery, Ruef, and Wiesendanger.

In the graduate program family management practices, their effects upon members of the family unit, and the interaction of such practices with the local and national economy are studied in relation to principles of economics, philosophy, psychology, sociology, and political science.

## HOME MANAGEMENT

Those interested in emphasizing a study of home management, family economics, family housing, and home equipment may do so through this major. There are no specific course requirements for admission.

### HOUSING AND HOME EQUIPMENT (HS EQ)

413. HOME EQUIPMENT (3)

470. HOUSING THE FAMILY (2-3)

### HOME MANAGEMENT AND FAMILY ECONOMICS (HM FE)

415. HOUSEHOLD BUYING PRACTICES (3)

419. MANAGING FAMILY FINANCIAL RESOURCES (3)

423. (F.N. 423). FAMILY FOOD PURCHASING (2)

424. ECONOMIC CONDITIONS IN RELATION TO THE FAMILY (3) *Miss Britton*

439. MANAGEMENT PRINCIPLES IN HOME OPERATION (2) *Miss Chennault*

442. RESIDENT EXPERIENCE IN HOME MANAGEMENT (3) Room and board will be charged at regular rates. *Miss Starr and Miss Chennault*

445. HOME MANAGEMENT EXPERIENCE (3) *Miss Starr*

477. FAMILY MANAGEMENT (3)

500. NONTHESIS RESEARCH (1-6) Nonthesis research problems.

515. CONSUMER PROBLEMS (2-3) Methods of securing, evaluating, and presenting data concerning household commodities. For home economics teachers in high schools, colleges, and adult classes. Prerequisites: F.N. 220, H.M.F.E. 442. *Miss Britton*

524. ECONOMIC PROBLEMS OF THE HOUSEHOLD (3) Economic problems of the present-day family; special emphasis on factors in household production, use of money income, and standards of living. Prerequisites: H.M.F.E. 439, Econ. 14. *Miss Britton*

528. HOME MANAGEMENT SUPERVISION (2-3) Evaluation of objectives and techniques in organization, supervision, and teaching of the home management house experience. Prerequisite: H.M.F.E. 439.

543. HOME MANAGEMENT IN RELATION TO FAMILY LIVING (3) Includes work with families in solution of their management problems. Prerequisites: F.N. 220, H.M.F.E. 439. *Miss Wiesendanger*

544. PROBLEMS IN HOME MANAGEMENT AND FAMILY ECONOMICS (1-6) Investigation of selected problems in home management and family economics. Prerequisite: 6 credits of home management or family economics courses in home economics.

550. SEMINAR IN HOME MANAGEMENT AND FAMILY ECONOMICS (1-6) Discussion and reports on developments in home management and family economics.

## HORTICULTURE

RUSSELL E. LARSON, *Head of the Department*  
102 Tyson Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Fleming, Hitz, Larson, Mastalerz, Meahl, and Odland; Associate Professors McArdle, Ritter, Smith, and Tukey; Assistant Professors Bergman, Pollack, and Walker.

Students may specialize in propagation, production, processing, breeding, nutrition, and other physiological studies of horticultural crop species, and in landscape design.

Prerequisites for major work in horticulture vary according to area of specialization; but basic courses in chemistry, mathematics, and the biological sciences are required. In addition, for students who wish to specialize in landscape architecture, basic courses in art and architecture and at least 30 credits in landscape architecture are required. Students who lack prerequisite courses may be admitted but are required to fulfill deficiencies without degree credit.

## HORTICULTURE (HORT)

- |                                                                                                                                                                                       |                      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| 412. STORAGE OF HORTICULTURAL CROPS (3)                                                                                                                                               | <i>Mr. Ritter</i>    |
| 418. SUBTROPICAL AND TROPICAL FRUITS (3)                                                                                                                                              |                      |
| 424. ADVANCED OLERICULTURE (3-6)                                                                                                                                                      | <i>Mr. Odland</i>    |
| 425. ADVANCED FRUIT AND VEGETABLE PROCESSING I (3)                                                                                                                                    | <i>Mr. McArdle</i>   |
| 426. ADVANCED FRUIT AND VEGETABLE PROCESSING II (3)                                                                                                                                   | <i>Mr. McArdle</i>   |
| 427. ADVANCED FLORICULTURE (3)                                                                                                                                                        | <i>Mr. White</i>     |
| 428. ADVANCED FLORICULTURE (3)                                                                                                                                                        | <i>Mr. Mastalerz</i> |
| 444. ADVANCED PLANT BREEDING (3-6)                                                                                                                                                    | <i>Mr. Walker</i>    |
| 446. ADVANCED POMOLOGY (3)                                                                                                                                                            |                      |
| 447. PROBLEMS IN HORTICULTURE (1-6)                                                                                                                                                   |                      |
| 453. NURSERY PRINCIPLES AND PRACTICE (3)                                                                                                                                              | <i>Mr. Meahl</i>     |
| 456. PROBLEMS IN NURSERY PRACTICE (3)                                                                                                                                                 | <i>Mr. Meahl</i>     |
|                                                                                                                                                                                       |                      |
| 500. ECOLOGY OF FRUIT PLANTS (3) Factors limiting the distribution and intensity of culture of fruit species and varieties and effect of environmental factors on cultural practices. | <i>Mr. Tukey</i>     |
|                                                                                                                                                                                       |                      |
| 501. EXPERIMENTAL PROBLEMS IN POMOLOGY (2-12) Investigation of problems involving review of literature, field and laboratory research.                                                |                      |
|                                                                                                                                                                                       |                      |
| 503. EXPERIMENTAL PLANT BREEDING (2-12) Problems based mainly on research work of the department, with review of experimental methods and literature. Prerequisite: Hort. 444.        | <i>Mr. Larson</i>    |
|                                                                                                                                                                                       |                      |
| 504. EXPERIMENTAL PROBLEMS IN OLERICULTURE (2-9) Investigation of problems involving review of literature, field and laboratory research. Prerequisite: Hort. 420 or 424.             | <i>Mr. Odland</i>    |
|                                                                                                                                                                                       |                      |
| 505. PROBLEMS IN VEGETABLE PRODUCTION (2-6) Methods used in the more valuable contributions to vegetable production. Prerequisite: Hort. 420 or 424.                                  | <i>Mr. Odland</i>    |



## HORTICULTURE

506. NUTRITION OF HORTICULTURAL CROPS (2-4) Principles, applications, and interpretations of diagnostic methods for determining fertilizer requirements of horticultural crops. *Mr. Smith*
512. PRINCIPLES OF FRUIT AND VEGETABLE STORAGE (2-4) Principles involved in the maturation, storage, and senescence of fruits and vegetables, and their application. *Mr. Ritter*
513. EXPERIMENTAL PROBLEMS IN ORNAMENTAL HORTICULTURE (2-12) Review of research in ornamental horticulture, with original investigations. *Mr. Meahl*
514. PROPAGATION OF ORNAMENTAL AND FRUIT PLANTS (3) Factors affecting the asexual and sexual propagation of fruit and ornamental plants. *Mr. Meahl*
517. HORTICULTURE SEMINAR (1 per semester) Review of current research publications in horticulture. Each student presents one or more reviews of assigned topics.
519. SEMINAR ON THE GENETICS OF HORTICULTURAL CROPS (1 per semester) Review of current research publications on the genetics of horticultural crops. Each student presents one or more reviews of literature on assigned topics.
520. SEMINAR ON THE BREEDING OF HORTICULTURAL CROPS (1 per semester) Each student presents one or more reviews of literature on assigned topics.
523. PROPAGATION AND IMPROVEMENT OF VEGETABLE AND FLOWER CROPS (3) Methods and special techniques in breeding of flowers and vegetables; maintenance of seed stocks and seed production. Prerequisite: Hort. 444. *Mr. Odland*
524. EXPERIMENTAL PROCEDURES IN HORTICULTURAL RESEARCH (3) *Mr. Larson*
525. HORTICULTURAL RESEARCH TECHNIQUES (3) Practice in and comparison of methods and apparatus used in horticultural research. *Mr. Hitz*
526. EXPERIMENTAL PROBLEMS IN FLORICULTURE (2-12) Greenhouse research and review of literature. Prerequisite or concurrent: Hort. 427, 428. *Mr. Mastalerz*
527. EXPERIMENTAL PROBLEMS IN NUTRITION OF HORTICULTURAL CROPS (2-12) Review of current research; problems for independent investigation. *Mr. Smith*
528. PROBLEMS IN FRUIT AND VEGETABLE PROCESSING (2-12) *Mr. McArdle*

## LANDSCAPE ARCHITECTURE (L ARCH)

434. (Rc.Ed. 434). RECREATION AREAS AND FACILITIES (3) *Mr. Steyers*
- 454-455. LANDSCAPE DESIGN (4 each) *Mr. Polakowski*
460. ADVANCED LANDSCAPE DESIGN (3-6) *Mr. Steyers*
461. PARK DESIGN AND ADMINISTRATION (3-6) *Mr. Wilson*
462. SITE PLANNING OF INSTITUTIONAL AND PUBLIC PROJECTS (3-6) *Mr. Steyers*
463. ADVANCED LANDSCAPE DESIGN (1-6) *Mr. Wilson*
518. ADVANCED PROBLEMS IN LANDSCAPE DESIGN (2-12) Selected problems for original investigation in the design, construction, and maintenance of landscape architectural projects. Prerequisite: L.Arch. 455.
521. TECHNICAL LANDSCAPE ARCHITECTURAL PRACTICES (2-12) Specific technical and professional problems in landscape architectural planning and practice. Prerequisites: L.Arch. 460, 461.

## INDUSTRIAL ARTS EDUCATION and VOCATIONAL INDUSTRIAL EDUCATION

S. LEWIS LAND, *Head of the Department of Industrial Education*  
301 Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Friese, Land, and Williams; Associate Professors Pendered and Schaefer.

Emphasis may be placed on preparation for teaching, supervision, administration, or teacher education. Graduation from an approved curriculum in industrial arts or in vocational industrial education is required for admission to the respective fields.

### INDUSTRIAL ARTS (I ART)

- 400. SHOP MANAGEMENT AND LAYOUT (3)
- 407. INDUSTRIAL ARTS EDUCATION (3)
- 421. CURRICULUM MATERIALS IN INDUSTRIAL ARTS (3)
- 470. PROBLEMS IN SENIOR HIGH SCHOOL INDUSTRIAL ARTS (3)
  
- 574. HISTORY AND PHILOSOPHY OF INDUSTRIAL ARTS (3) Historical developments and concurrent educational philosophies of industrial arts in American education. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.
- 575. PROBLEMS IN INDUSTRIAL ARTS EDUCATION (3) Subject matter, projects, methods of manual and informational teaching, aids and devices, selection of text and reference materials, personnel organization, shop management, problem pupils. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.
- 576. SUPERVISION AND ADMINISTRATION OF INDUSTRIAL ARTS EDUCATION (3) How to organize, supervise, and administer functioning programs of industrial arts; duties of a supervisor and director of industrial arts. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.
- 577. TESTING IN INDUSTRIAL ARTS (3) Construction of informal manipulative and written tests; use of standardized mechanical aptitude and achievement tests; construction and use of rating scales; scoring and grading; interpretation of test results. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.
- 578. RESEARCH IN INDUSTRIAL ARTS (3) Research techniques in industrial arts education. Prerequisite: 6 credits in professional courses in industrial arts.
- 580. SEMINAR IN INDUSTRIAL ARTS (9) Directed intensive study, investigation, or research in selected phases of the program; reports and constructive criticism. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.

## INDUSTRIAL EDUCATION

### INDUSTRIAL EDUCATION (I ED)

- 402v. SUPERVISION OF VOCATIONAL EDUCATION (3)  
403v. SUPERVISED FIELD WORK (6)  
408v. OCCUPATIONS (3)  
409v. TESTS AND MEASUREMENTS (3)  
412v. SPECIAL PROBLEMS IN VOCATIONAL EDUCATION (4)  
415v. PROBLEMS IN CO-ORDINATING VOCATIONAL EDUCATION (3)  
420v. OCCUPATIONAL HYGIENE (3)  
427v. ADVANCED COURSE OF STUDY BUILDING (3)  
446v. IMPROVEMENT OF INSTRUCTION IN VOCATIONAL EDUCATION (4)  
450v. SHOP LAYOUT AND MANAGEMENT (3)  
460. PROBLEMS IN VOCATIONAL REHABILITATION OF THE HANDICAPPED (3 per unit)  
    Unit A. *The Counseling Interview in Vocational Rehabilitation* (3)  
    Unit B. *Occupational Information and Placement Techniques in Vocational Rehabilitation* (3)
- 501v. SEMINAR IN VOCATIONAL EDUCATION (12) Conferences, investigations, and discussion for advanced students and mature persons who have had experience as teachers, supervisors, or administrators.
- 506v. ADMINISTRATION OF VOCATIONAL EDUCATION (6) The job of the local director of industrial education in organizing and developing city and other local programs of industrial education. Prerequisite: 6 credits in industrial education or valid director's certificate, equivalent training and experience.
- 510v. VOCATIONAL EDUCATION FOR ADMINISTRATORS (3) Designed for school administrators and supervisors who desire an understanding of practical arts and vocational education. Prerequisite: I.Ed. 1v or trade or teaching experience.
- 550v. RESEARCH IN VOCATIONAL EDUCATION (3) Research techniques in vocational industrial education.
- 555v. CURRENT PROBLEMS IN VOCATIONAL EDUCATION (1 per unit) Recent trends and developments in part-time, full-time, and evening school education, involving critical analysis of objectives, content, and outcome.  
    Unit A. *Changing Industrial, Economic, and Social Conditions* (1)  
    Unit B. *Policies and Program of the American Vocational Association* (1)  
    Unit C. *Federal and State Vocational Legislation, Present and Pending* (1)  
    Unit D. *Financing Vocational Education* (1)  
    Unit E. *Current Administrative Problems in Vocational Education* (1)  
    Unit F. *Current Administrative Problems in Vocational Education (cont'd)* (1)
- 558v. FRONTIER PROBLEMS IN VOCATIONAL INDUSTRIAL EDUCATION (3 per unit).  
    Unit A. *Federal Legislation* (3) Recent federal legislative activities and executive orders that bear directly and indirectly upon industrial education.  
    Unit B. *Present-Day Local, Personnel, and Curriculum Problems* (3) Various plans, techniques, and practices.  
    Unit C. *State and Local Supervision and Administration* (3) The more important recent problems in organization, supervision, and administration.



- 560v. PHILOSOPHY OF INDUSTRIAL EDUCATION (3) Principles and beliefs of progressive industrial education; literature for evaluating instructional practices. Prerequisite: 12 credits in industrial education or teaching experience.

## INDUSTRIAL ENGINEERING

BENJAMIN W. NIEBEL, *Head of the Department*  
203 Engineering C

*Degrees Conferred:* M.S., M.Eng.

*Graduate Faculty:* Professors Niebel and Thuring.

Graduate study and research are conducted in operations research, linear programming, queueing theory, and experimental design. Opportunities also exist for advanced study in automation, production engineering, product design for production, work measurement, costs and budgets, tool design, methods analysis, personnel management, and management controls.

For admission a student must have graduated from an accredited school with a major in industrial engineering. Graduates of other accredited engineering curriculums may be admitted after completing 27 credits in industrial engineering.

### INDUSTRIAL ENGINEERING (I E)

- |                                                                                                                                                                                                                                             |                                            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|
| 400. ENGINEERING FOR PRODUCTION (3)                                                                                                                                                                                                         | <i>Mr. Niebel</i>                          |
| 402. ENGINEERING ECONOMY (3)                                                                                                                                                                                                                | <i>Messrs. Niebel, Roscoe, and Thuring</i> |
| 404. SCIENTIFIC MANAGEMENT (2)                                                                                                                                                                                                              | <i>Messrs. Caldwell and Roscoe</i>         |
| 406. FACTORY PLANNING (2)                                                                                                                                                                                                                   | <i>Messrs. Thuring, Draper, and Olsen</i>  |
| 422a,b,c,d,e,f. INDUSTRIAL ENGINEERING PROBLEMS (2-12)                                                                                                                                                                                      | <i>Messrs. Niebel, Thuring, and Moss</i>   |
| 423. QUALITY CONTROL (2)                                                                                                                                                                                                                    | <i>Mr. Thuring</i>                         |
| 424. JOB EVALUATION (3)                                                                                                                                                                                                                     | <i>Mr. Farwell</i>                         |
| 425. METHODS OF INDUSTRIAL OPERATIONS RESEARCH (3)                                                                                                                                                                                          | <i>Mr. Guild</i>                           |
| 426. INDUSTRIAL AUTOMATION (3)                                                                                                                                                                                                              | <i>Mr. Bowman</i>                          |
| 429. PLASTIC WORKING OF METALS (3)                                                                                                                                                                                                          | <i>Mr. Roscoe</i>                          |
| 430. INDUSTRIAL LEADERSHIP (3)                                                                                                                                                                                                              | <i>Mr. Caldwell</i>                        |
| 432. INDUSTRIAL ENGINEERING LECTURES (1-3)                                                                                                                                                                                                  |                                            |
|                                                                                                                                                                                                                                             |                                            |
| 501. MANUFACTURING METHODS (2-8) Special projects including investigation; experimentation, design, and research of one or more special types of manufacture.                                                                               | <i>Messrs. Niebel and Thuring</i>          |
| 502. MANAGEMENT METHODS (3-6) Scientific management, including management controls and mathematical programming; research on special problems.                                                                                              | <i>Messrs. Thuring and Niebel</i>          |
| 503. PERSONNEL RELATIONS (2-8) Research on special topics.                                                                                                                                                                                  | <i>Mr. Williamson</i>                      |
| 505. GRAPHICAL COMPUTATION (2-6) Construction of natural and logarithmic scales, applications of various co-ordinate papers and construction of nomographic or alignment charts; determination of empirical formulae from engineering data. | <i>Mr. Thuring</i>                         |

## INDUSTRIAL ENGINEERING

506. TIME AND MOTION STUDY (3-9) Methods of research in motion and time study; critical analysis of current literature. *Mr. Niebel*
507. BUDGETARY CONTROL AND STANDARD COSTS (3-6) Divisional budgets as control media; establishing standard cost data, standard cost accounting procedures, and use of cost variances in controlling manufacturing operations. Prerequisite: I.E. 335.
513. DATA PROCESSING AND PROGRAMMING (3) Theory and techniques in systems analyses applied to the programming of procedures and operations.

## INSTITUTION ADMINISTRATION

S. EARL THOMPSON, *Head of the Department*  
4A Home Economics Building

*Degree Conferred:* M.S.

*Graduate Faculty:* Professors Atkinson and Thompson.

Graduate work in this field trains for management positions in institutions which provide food service and housing to large groups, such as hospitals, residence halls, children's homes, and other public and private organizations. For admission, a student should have a baccalaureate degree in this or a related field.

### HOTEL ADMINISTRATION (H A)

440. HOTEL OPERATIONAL LIABILITIES (2)  
445. HOTEL ORGANIZATION AND OPERATION (3)

### INSTITUTION ADMINISTRATION (IN A)

402. FOOD SERVICE AND HOUSING LAYOUT AND DESIGN (2)  
410. TEA ROOM MANAGEMENT (3)  
437. SCHOOL CAFETERIA PROBLEMS (1 per unit)  
    *Unit A. Nutrition and Menu Planning (1)*  
    *Unit B. Equipment (1)*  
    *Unit C. Organization and Management (1)*  
461. INSTITUTION ADMINISTRATION (3)  
462. INSTITUTION EXPERIENCE (3)  
502. PROBLEMS IN INSTITUTIONAL ADMINISTRATION (3-6) Individual study of problems in institutional administration. Prerequisites: In.A. 326, 330.  
*Miss Atkinson*

## JOURNALISM

JAMES W. MARKHAM, *Chairman of the Graduate Program*  
115 Carnegie Building

*Degree Conferred:* M.A.

*Graduate Faculty:* Professors Brown, Marbut, and Markham; Associate Professor Hicks; Assistant Professors Froke and Pockrass.

## JOURNALISM

The student may pursue studies in the fields of news and public affairs reporting, editing, and comment in the mass media; advertising; technical problems in broadcasting and publishing; and public relations.

For admission under Plan A the student must present evidence of undergraduate credit covering the fundamentals, or equivalent professional experience in mass communications. Students who lack these prerequisites may enroll under Plan B, which may require a maximum of 18 undergraduate credits in basic communications.

### JOURNALISM (JOURN)

- |      |                                                       |                                   |
|------|-------------------------------------------------------|-----------------------------------|
| 401. | THE PRESS, ITS CRITICS AND ETHICS (2)                 | <i>Mr. Dennis</i>                 |
| 405. | COMPARATIVE FOREIGN JOURNALISM (2)                    | <i>Messrs. Markham and Dennis</i> |
| 424. | PUBLIC AFFAIRS REPORTING (3)                          | <i>Mr. Goodwin</i>                |
| 430. | SUPERVISION AND MANAGEMENT OF SCHOOL PUBLICATIONS (3) | <i>Mr. Vairo</i>                  |
| 441. | ADVANCED ADVERTISING COPYWRITING (3)                  | <i>Mr. Hicks</i>                  |
| 443. | ADVERTISING CAMPAIGNS (3)                             |                                   |
| 466. | PUBLICITY AND PUBLIC RELATIONS PROBLEMS (3)           | <i>Mr. Vairo</i>                  |
| 468. | LAW OF MASS COMMUNICATIONS (3)                        | <i>Messrs. Marbut and Markham</i> |
| 480. | MEDIA MANAGEMENT (3)                                  |                                   |
| 492. | ADVANCED TELEVISION NEWS (3)                          |                                   |
505. INTERNATIONAL PRESS PROBLEMS (3-6) Legal and communications problems of the international flow of news and opinion; international press codes.  
*Mr. Markham*
506. SEMINAR IN COMMUNICATIONS RESEARCH METHODS (3-6) Social science measuring techniques for readership and advertising studies, media effectiveness, and propaganda results.  
*Mr. Markham*
508. HISTORY AND LITERATURE OF JOURNALISM (3) Readings and research in biography, history, collections of journalistic writings, and critical works.  
*Mr. Brown*
513. CURRENT PROBLEMS IN NEWS REPORTING AND EDITING (3) Securing, writing, display, and treatment of the news; newsroom policies and ethics.  
*Mr. Marbut*
521. NEWS MEDIA AND PUBLIC OPINION (3) Problems in the function, techniques, and responsibilities of press, radio, and television in forming and interpreting opinion. Prerequisite: Pl.Sc. 427, Psy. 429, or Soc. 431.  
*Mr. Pockrass*
540. CONTEMPORARY ADVERTISING PROBLEMS (3) Current problems and trends in the fields of advertising copy, media, planning, and research; policies and ethical standards.  
*Mr. Hicks*

## MATHEMATICS

ORRIN FRINK, *Head of the Department*  
210 Sparks Building

*Degrees Conferred:* Ph.D., D.Ed., M.A., M.Ed.

*Graduate Faculty:* Professors Benton, Cohen, Curry, Orrin Frink, Johnson, Krall, and Sheffer; Associate Professors Ayoub, Barone, Bartoo, Craig, Aline Frink,



## MATHEMATICS

Hostinsky, Kanwal, Mitchell, and Schoenfeld; Assistant Professors Faith, Hiz, Johnson, Kist, Lister, Mack, Novosad, Pervin, and Raney.

Graduate courses in all the principal branches of mathematics are offered each year. The department is prepared to direct research in a variety of fields, including function theory, abstract algebra, topology, number theory, statistics, numerical analysis, and all aspects of mathematical logic and foundations. A digital computer is available on the campus for students interested in numerical methods.

To be admitted without undergraduate deficiency, an applicant should have credit for at least two advanced courses beyond integral calculus.

### MATHEMATICS (MATH)

- 403. MODERN METHODS IN GEOMETRY (3)
- 404. THEORY OF NUMBERS (3)
- 405. PARTIAL DIFFERENTIAL EQUATIONS (3)
- 407. FOUNDATIONS OF ALGEBRA AND GEOMETRY (3)
- 408. APPLICATIONS OF MATHEMATICS (3)
- 409-410. PROBABILITY AND STATISTICS (3 each)
- 411. FINITE DIFFERENCES (3)
- 412. ALGEBRAIC EQUATIONS (3)
- 413-414. MATHEMATICS OF SCIENCE FOR TEACHERS (3 each)
- 415. SURVEY OF MODERN MATHEMATICS FOR TEACHERS (3)
- 416. MATHEMATICAL LOGIC FOR TEACHERS (3)
- 417. VECTOR AND TENSOR ANALYSIS (3)
- 419. ANALYTICAL MECHANICS (3)
- 420-421. ADVANCED CALCULUS (3 each)
- 428. (Phil. 428). LOGICAL THEORY (3)
- 431. DIFFERENTIAL EQUATIONS (3)
- 441. DETERMINANTS AND MATRICES (3)
- 451-452. INTRODUCTION TO APPLIED MATHEMATICS (3-6 each)
- 453. MATHEMATICS FOR DIGITAL COMPUTERS (3)
- 471. FOUNDATIONS OF ALGEBRA (3)
- 472. FOUNDATIONS OF GEOMETRY (3)
- 473. ELEMENTS OF SET THEORY AND TOPOLOGY (3)
- 481. VECTORS AND MATRICES (3)
- 491. TOPICS IN APPLIED MATHEMATICS (3-9)
  
- 500. ANALYTICAL MECHANICS (3) An exposition of rigid dynamics, the potential function, and Lagrange's equations. Prerequisite: Math. 419 or Phys. 461.
- 501-502. THEORY OF FUNCTIONS OF A REAL VARIABLE (3 each) Theory of real functions, sets, measure, derivatives, and integrals. Prerequisite: Math. 420.
- 503. FOURIER SERIES AND HARMONIC FUNCTIONS (3) Fourier series and integrals; spherical harmonics, Bessel functions, etc., with special emphasis on their applications. Prerequisites: Math. 44, 420.
- 505. INTEGRAL EQUATIONS (3) Fredholm and Volterra equations, and applications. Prerequisite: Math. 421.
- 507. CALCULUS OF VARIATIONS (3) Prerequisites: Math. 44, 421.

- 508-509. THEORY OF FUNCTIONS OF A COMPLEX VARIABLE (3 each) Development of the complex number system; theory of analytic functions. Prerequisite: Math. 421.
510. THEORY OF GROUPS (3) General properties of groups with applications. Prerequisite: Math. 471 or 535.
511. LINEAR ALGEBRA AND MATRIX THEORY (3) Vector spaces and linear transformations, canonical representations, elementary divisors and invariant factors. Prerequisite: Math. 481.
- 513-514. ADVANCED ANALYTIC GEOMETRY (3 each) Introduction of homogeneous coordinates and their use in the study of projective properties. Prerequisite: Math. 43.
- 520-521. PROJECTIVE GEOMETRY (3 each) General study of the subject from the postulational standpoint. Prerequisite: Math. 43. Alternate years or as required.
- 522-523. METRIC DIFFERENTIAL GEOMETRY (3 each) The usual classical treatment of the subject. Prerequisite: Math. 43.
- 530-531. TOPOLOGY (3 each) Topological spaces, combinatorial topology, applications to algebra and analysis.
532. THEORY OF SETS (3) Formal development of set theory on a logical basis and related methodological problems; applications to the foundations of mathematics. Prerequisite: Math. (Phil.) 428.
534. THEORY OF ALGEBRAIC NUMBERS (3) Introduction to the number theory of quadratic fields, with study of the theory of ideals in quadratic and higher fields, with application. Prerequisite: Math. 404, 471.
- 535-536. MODERN ALGEBRAIC THEORIES (3 each) Groups, rings, ideals, algebraic number fields, Galois theory. Prerequisite: Math. 471.
- 542-543. THEORY OF STATISTICS (3 each) Univariate and multivariate distributions, sampling distributions, theory of estimation, statistical hypotheses. Prerequisites: Math. 409, 421.
- 550-551. (Phil. 550-551). MATHEMATICAL LOGIC (3 each) The logical basis of mathematics and its ultimate nature. Prerequisite: Math. 471, or Math. (Phil.) 428.
- 552-553. NUMERICAL METHODS (3 each) Procedures for practical calculation, including interpolation, solution of equations, iterative methods, harmonic analysis, and use of modern calculating equipment. Prerequisite: Math. 420.
554. (Phil. 554). METAMATHEMATICS (3) Prooftheoretic and modeltheoretic study of systems: Gödel's theorem, relative and absolute consistency proofs, decidability, properties of relational structures, mathematical applications. Prerequisite: Math. (Phil.) 428.
555. SELECTED TOPICS IN MATHEMATICS FOR CHEMISTS (3) An introduction to matrices, groups, group representations, characters, and orthogonal functions.
- 560-561. THEORY OF DIFFERENTIAL EQUATIONS (3 each) Prerequisites: Math. 44, 421.

## MATHEMATICS

565. FUNCTIONAL ANALYSIS (3) Theory of Banach and Hilbert spaces, including functionals and operators, and related topics. Prerequisite: Math. 420.
570. SPECIAL TOPICS IN GEOMETRY (3-6)
571. SPECIAL TOPICS IN ANALYSIS (3-6)
572. SPECIAL TOPICS IN ALGEBRA (3-6)
573. SPECIAL TOPICS IN APPLIED MATHEMATICS (3-6)
574. SPECIAL TOPICS IN FOUNDATIONS OF MATHEMATICS (3-6)
- 575-576. MATHEMATICS SEMINAR (1-6 each) Selected topics from recent mathematical developments.

## MECHANICAL ENGINEERING

NORMAN R. SPARKS, *Head of the Department*  
207 Mechanical Engineering Building

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Professors Ambrosius, Dusinberre, Gjesdahl, Hussmann, Meyer, and Sparks; Associate Professors Brickman, DiIlio, Lester, and White.

Graduate programs in mechanical engineering emphasize heat power or machine design. Courses and facilities permit studies in heat transfer, advanced machine design, internal combustion engines, machine dynamics, gas turbines and gas dynamics, lubrication, automatic control systems, and power generation and utilization.

To be admitted, a student should be a graduate of an accredited curriculum in mechanical engineering or the equivalent. Graduates of other accredited engineering or physical science curriculums may be admitted, but will be required to make up undergraduate deficiencies without graduate credit.

### MECHANICAL ENGINEERING (M E)

- 401a,b,c,d. MECHANICAL ENGINEERING (3-12)
402. AIR CONDITIONING (3)
403. ROCKET PROPULSION (3)
409. GAS TURBINES (3)
410. POWER PLANTS (3)
411. REFRIGERATION (3)
412. FUNDAMENTALS OF HEAT TRANSFER (3)
413. INTERNAL COMBUSTION ENGINES (3)
417. THEORY OF ENGINEERING INSTRUMENTS (3)
418. PRINCIPLES OF TURBOMACHINERY (3)
450. DESIGN OF MACHINE TOOLS (3)
451. ADVANCED MACHINE DESIGN PROBLEMS (3)
452. MACHINE DESIGN ANALYSIS (3)
453. BEARING DESIGN AND LUBRICATION (3)



## MECHANICAL ENGINEERING

455. AUTOMATIC CONTROL SYSTEMS (3)  
457. ADVANCED MECHANISMS (3)
502. ADVANCED GAS TURBINES (3-6) Analytical study of gas turbine compressors and turbines; combustion; complex cycles; recent developments. Prerequisite: M.E. 409.
504. ADVANCED ENGINEERING THERMODYNAMICS (3-6) Pure and applied thermodynamics including its application to advanced engineering problems; collateral reading and discussion of the classical works on the subject. Prerequisite: M.E. 32.
505. HEAT TRANSMISSION (3-6) Applications of principles of heat transfer to efficient design of mechanical engineering equipment. Prerequisite: M.E. 412.
506. MECHANICAL ENGINEERING SEMINAR (1-4) Advanced courses adapted to the individual requirements of graduates in mechanical engineering.
507. ADVANCED INTERNAL COMBUSTION ENGINES (3) Performance and design of carburetor and fuel-injection reciprocating engines, including compound and free-piston types, from the thermodynamic viewpoint. Prerequisite: M.E. 413.
510. MIXTURE PREPARATION AND COMBUSTION IN INTERNAL COMBUSTION ENGINES (3-6) Performance and design of carburetors and injection systems; combustion and its control in spark-ignition and compression-ignition engines. Prerequisite: M.E. 413.
550. ANALYSIS OF DESIGN PROBLEMS (3) Case problems in machine design requiring integrated application of engineering knowledge.
552. ADVANCED DYNAMICS OF MACHINES (3-6) Linear and torsional vibrations in and balancing of rotating and reciprocating machinery; exact analysis of stresses produced by these and other dynamic forces in machine parts. Prerequisites: E.Mch. 12, M.E. 54.
553. FRICTION AND LUBRICATION (3) The hydrodynamic theory of lubrication and methods of applying it to bearing design, together with a survey of methods of testing lubricants.
555. AUTOMATIC CONTROL SYSTEMS (3) Advanced problems and techniques in the design of automatic control systems with emphasis on stability, controller design, and optimum performance. Prerequisite: M.E. 455.
557. MECHANISM SYNTHESIS (3) Design and analysis of mechanisms for specific motion and energy requirements; intermittent mechanisms. Prerequisite: M.E. 457.
580. INVESTIGATION PROJECTS (2-6) Special experimental studies or investigations in mechanical engineering, adapted to individual requirements.

## METALLURGY

AMOS J. SHALER, *Head of the Department*  
5 Mineral Sciences Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Davis, Lindsay, Read, and Shaler; Associate Professor Muan; Assistant Professor Oliver.

## METALLURGY

There is opportunity for a student to specialize, both in research and in course work, in chemical metallurgy, physical metallurgy, mechanical metallurgy, or the science of metals. Minor work in any of these specializations is available for students majoring in another field.

The requirements for admission are a satisfactory bachelor's degree in metallurgy, metallurgical engineering, chemistry, chemical engineering, physics, mechanical engineering, or engineering mechanics; or a satisfactory bachelor's degree in another field, provided it has included the equivalents of mathematics through integral calculus; 8 credits of physics; 12 of chemistry; 10 of other scientific, engineering, or mineral science fields; and 10 of metallurgy. Students who lack some of these requirements may be admitted but are required to take the prerequisite courses without being able to apply them toward an advanced degree.

### METALLURGY (METAL)

- 405. FERROUS METALLOGRAPHY (3)
- 406. NONFERROUS METALLOGRAPHY (3)
- 407. METALLURGICAL ENGINEERING I (3)
- 408. METALLURGICAL ENGINEERING II (3)
- 409. METALLURGICAL INVESTIGATIONS I (3)
- 410. METALLURGICAL INVESTIGATIONS II (3)
- 411. ADVANCED PHYSICAL METALLURGY (3)
- 412. EXPERIMENTAL METALLURGY (3)
- 413. ADVANCED CHEMICAL METALLURGY (3)
  
- 501. METALLURGICAL PROBLEMS (1-6 per semester) Independent study of special problems in metallurgy. Prerequisites: Metal. 411, 413.
- 502. SEMINAR IN METALLURGY (1-6) Conferences, reading, reports, and special lectures.
- 505. NUCLEAR REACTOR MATERIALS (3) Extractive metallurgy, alloy theory, transformations, physical properties, mechanical behavior, and corrosion of principal reactor materials; radiation damage; fuel element manufacture. Prerequisites: Metal. 59, E.Mch. 13.
- 515. CORROSION OF METALS (3) Phenomena and theories of metallic corrosion; principles of alloy selection for engineering and structural uses in corrosive environments. Prerequisites: Metal. 411, 413. *Mr. Read*
- 516. FLOW AND FRACTURE OF SOLIDS (3) Phenomenological and theoretical treatment of flow and fracture in solids. *Mr. Shaler*
- 518. CONSTITUTION OF METALLURGICAL SYSTEMS (3) Application of thermodynamic principles to study of heterogeneous equilibrium in alloy, slag, and slag-metal systems. Prerequisites: Metal. 411, 413. *Mr. Davis*
- 519. ADVANCED FERROUS METALLURGY (3) Physicochemical principles in the smelting and refining of iron and steel; slag control; solidification and primary forging of steel. Prerequisites: Metal. 411, 413. *Mr. Muan*
- 520. FOUNDRY METALLURGY (3) Principles of foundry metallurgy; application to foundry operations for various ferrous and nonferrous casting alloys. Prerequisites: Metal. 411, 413. *Mr. Lindsay*

522. SOLID-PHASE REACTIONS IN METALS (3) Mechanism and rate determining factors in solid-phase reactions in metals; diffusion processes, nucleation theory, precipitations from solid solution, eutectoid decomposition and order-disorder phenomena. Prerequisites: Metal. 411, 413. *Mr. Lindsay*
524. ADVANCED METAL WORKING (3) Elements of mathematical theory of plasticity; metal working processes; measurement of deformations in metal working; theory of metal working. Prerequisite: Metal. 516. *Mr. Shaler*
525. METAL FINISHING (3) Metallic coatings and their metallurgical properties; theories and problems of application, utilization, and evaluation. Prerequisites: Metal. 411, 413. *Mr. Read*

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in metallurgical studies are listed under Mineral Sciences in Part II of this bulletin.*

## METEOROLOGY

HANS NEUBERGER, *Head of the Department*  
322 Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Neuberger and Panofsky; Associate Professors Blackadar, Hosler, and Stephens.

Candidates in meteorology may specialize in aerosol and cloud physics, various phases of dynamic meteorology including turbulence and atmospheric circulation, atmospheric optics, macro- and microclimatology, agricultural meteorology, synoptic meteorology, or meteorological instrumentation.

Requirements for admission include mathematics through differential equations, one year of college physics, and 12 credits in meteorology. Students with a strong background in mathematics, physics, or engineering may be admitted with deficiencies but must make up such deficiencies before they are admitted to candidacy for a degree.

### METEOROLOGY (METEO)

400. METEOROLOGY FOR TEACHERS (3)  
411. INTRODUCTION TO SYNOPTIC METEOROLOGY (3)  
412. SYNOPTIC METEOROLOGY (3)  
418. INTRODUCTORY PHYSICS OF THE UPPER ATMOSPHERE (3)  
420. TROPICAL METEOROLOGY (3)  
430. INTRODUCTION TO SYNOPTIC METEOROLOGY LABORATORY (3)  
431. SYNOPTIC METEOROLOGY LABORATORY I (3)  
432. SYNOPTIC METEOROLOGY LABORATORY II (2-10)  
433. ADVANCED SYNOPTIC ANALYTICAL TECHNIQUES (3)  
443. PHYSICAL METEOROLOGY (3)  
445. HYDROMETEOROLOGY (3)  
450. APPLICATIONS OF STATISTICS TO METEOROLOGY (3)  
451. THERMODYNAMICS OF THE ATMOSPHERE (3)



## METEOROLOGY

452. HYDRODYNAMICS OF THE ATMOSPHERE (3)  
461. THEORY OF METEOROLOGICAL INSTRUMENTS (3)  
472. PHYSICAL AND DYNAMIC CLIMATOLOGY (3)  
492. METEOROLOGICAL SEMINAR (2)
500. METEOROLOGICAL SEMINAR (1-3) Discussion of meteorological reports and papers; scientific outlook. Prerequisites: Meteo. 412, 451.
502. SELECTED TOPICS OF ADVANCED METEOROLOGY (2) Current problems in meteorology. Prerequisite: a minimum of 15 credits in meteorology.
503. ATMOSPHERIC TURBULENCE (3) Atmospheric diffusion, heat conduction, friction, and evaporation; statistical properties of turbulence.
504. ADVANCED DYNAMIC METEOROLOGY (3) Introduction to perturbation theory with application to gravitational and long waves; principles of dynamic-numerical forecast methods. Prerequisite: Meteo. 452.
505. BIOCLIMATOLOGY (2) Climatic phenomena in their relation to life. Prerequisite: Meteo. 472.
506. ADVANCED METEOROLOGICAL ANALYSIS (2-6) Physical analysis of atmospheric phenomena; synoptic analysis of weather phenomena for advanced students. Prerequisite: Meteo. 412.
507. DYNAMIC OCEANOGRAPHY (2) Physical properties of sea water; heat balance of the oceans; theory and observations of ocean currents, waves, and tides.
508. PHYSICS OF THE UPPER ATMOSPHERE (2) Temperature distribution, composition, and electrical characteristics of the upper atmosphere; theories of aurora and light of the night sky.
509. THEORETICAL CLIMATOLOGY (2) Theory of latitudinal, annual, and diurnal temperature changes; theories of climatic changes; microclimate.
510. CLOUD PHYSICS (2) Current theories on phase changes in clouds and mechanisms responsible for precipitation; techniques of cloud modification and control.

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in meteorological studies are listed under Mineral Sciences in Part II of this bulletin.*

## MINERAL ECONOMICS

JOHN D. RIDGE, *Head of the Department*  
207 Mineral Sciences Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professor Ridge; Associate Professor Schanz.

A student may specialize in the economics of exploration for, and the extraction, beneficiation, and utilization of, the ferrous and nonferrous metals, the nonmetals, the fuels, and ground water. Work is also offered in property evaluation,

analysis of mineral data, and the influence of technological advances on mineral economics.

The requirements for admission are 24 credits in chemistry, physics, and mathematics; 12 in geology, mineralogy, and/or the biological sciences; 9 in mineral economics, economics, commerce, and/or geography; and 6 in mining, metallurgy, petroleum engineering, ceramics, and/or industrial engineering.

Students having a deficiency of 9 credits or fewer in this total of 51 may be admitted as regular graduate students but will be required to make up such deficiencies without the credits being applicable toward the advanced degree.

## MINERAL ECONOMICS (MN EC)

- 400. SEMINAR (1)
- 453. NONMETALLIC MINERALS (3)
- 463. MINERAL ECONOMY OF THE U.S.S.R. (3)
- 483. THE METALS AND THEIR ORES (3)
- 484. THE SOLID FUELS (3)
- 486. PETROLEUM AND NATURAL GAS ECONOMICS (3)
- 490. MINERAL VALUATION (3)
- 491. ANALYSIS OF MINERAL DATA (2)
  
- 500. ADVANCED PRINCIPLES OF MINERAL ECONOMICS (3-6) Economic history of mineral industries, research methods, economics of mineral exploitation and utilization, mineral policy.
- 501. RESEARCH IN MINERAL ECONOMICS (3-6) Investigation in specialized fields of research in mineral economics. Prerequisite: 3 credits in Mn.Ec. 500.
- 502. TECHNOLOGIC INFLUENCES (3-9) Relationship of technologic advancements to economic development of the mineral industries. Prerequisite: 3 credits in Mn.Ec. 500.
- 505. PROBLEMS OF MINERAL ECONOMICS (3-12) Determination of basic technologic-economic patterns of selected mineral industries. Prerequisite: 3 credits in Mn.Ec. 500.

## MINERAL PREPARATION

H. BEECHER CHARMBURY, *Head of the Department*  
4 Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.  
*Graduate Faculty:* Professors Charmbury and Sun.

Areas in which students may specialize include the fundamentals of gravity, electrical, and chemical methods of beneficiating natural mineral deposits. Graduate work may also be undertaken on the properties of specific minerals as they are related to beneficiation.

Graduates with a bachelor's degree in such scientific fields as chemistry, physics, and mathematics, and in such engineering fields as mining, metallurgy, ceram-

## MINERAL PREPARATION

ics, fuel technology, and mechanical, electrical, and civil engineering are eligible for admission. However, graduates in the above fields are required to take 6 credits of undergraduate courses in mineral preparation along with their graduate program.

### MINERAL PREPARATION (MN PR)

- 400. MINERAL PREPARATION SEMINAR (1)
- 403. FLOWSHEETS OF MINERAL PREPARATION PLANTS (3)
- 404. PLANT LAYOUT AND DESIGN (3)
- 410. COAL PREPARATION (3)
- 415. MINERAL PREPARATION TESTING (2)
- 416. UNIT OPERATIONS (3)
- 457. FIELD TRIP (1)
  
- 502. FROTH FLOTATION AND AGGLOMERATION (3) Intensive study of theory and applications of froth flotation and agglomeration. Prerequisite: Mn.Pr. 416. Mr. Sun
- 504. MINERAL PREPARATION RESEARCH (1-6 per semester) Research work on specific problems in mineral preparation. Prerequisite: Mn.Pr. 416 or 410. Mr. Charmbury and Staff
- 505. GRAVITY PROCESSES AND MISCELLANEOUS METHODS OF MINERAL PREPARATION (3) Intensive study of theory and applications of gravity, magnetic, electrostatic, centrifugal, and dense-media processes of mineral concentration. Prerequisite: Mn.Pr. 416. Mr. Mitchell
- 506. MINERAL PREPARATION PLANT DESIGN (3-10) Layout, design, and selection of equipment for specific mineral preparation plant projects. Prerequisite: Mn.Pr. 416. Mr. Mitchell

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in mineral preparation studies are listed under Mineral Sciences in Part II of this bulletin.*

## MINERALOGY AND PETROLOGY

JOHN C. GRIFFITHS, *Head of the Department of Mineralogy*  
114 Mineral Sciences Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Bates, Griffiths, and Krynine; Associate Professors Smith and Wright; Assistant Professor Thornton.

Areas of specialization include igneous, sedimentary, and metamorphic petrology, mineralogy, crystal chemistry, X-ray mineralogy, clay mineralogy, ore mineralogy, and applications of statistics in the earth sciences.

The general requirements for admission are mathematics through integral calculus, chemistry through quantitative analysis, 10 credits of general physics, 30 credits of geology, petrology, and mineralogy including microscopical petrography (i.e., an equivalent to Min. 483, acceptable to the faculty).



Additional specific requirements must be fulfilled in most areas of specialization. Deficiencies may, in most cases, be made up after admission.

## MINERALOGY (MIN)

460. OPTICAL MINERALOGY (3) *Mr. Wright*  
 483. PETROGRAPHY (4) *Messrs. Griffiths and Thornton*
500. OPTICAL CRYSTALLOGRAPHY OF MINERALS (3) Optical methods, microscopic techniques, and measurement of optical constants of crystals; theory and application of the universal stage. Prerequisite: Min. 460. *Mr. Wright*
- 501a. PETROLOGY (3-6) Microscopic study of rocks, emphasizing classification and genetic relationships. *Messrs. Krynine, Tuttle, and Griffiths*
502. MINERALOGICAL PROBLEMS (3) Original study of some limited mineralogical or petrological problems.
504. THEORETICAL MINERALOGY (3) Crystal chemistry and crystal physics applied to solid solution, polymorphism, crystal growth, and related phenomena. *Mr. Bates*
505. MINERALOGY SEMINAR (1-2) Reading, presentation, and discussion of literature dealing with various phases of theoretical mineralogy. Topics are selected to meet the interests of the majority of the students. *Messrs. Krynine, Tuttle, Bates, Griffiths, and Brindley*
- \*510. METAMORPHIC PETROLOGY (2-6) Detailed review of chemical, mineralogical, and structural changes that take place during metamorphism. Prerequisite: Min. 483. *Mr. Thornton*
511. SEDIMENTARY PETROLOGY (3-4) Composition, texture, structure, mass properties of sediments; dynamic processes in complex natural systems; sedimentary stages: weathering, erosion, transport, deposition, and lithification. Prerequisite: Min. 483. Concurrent: Min. 513. *Mr. Krynine*
512. SEDIMENTARY PETROLOGY, CONTINUED (2-4) Diastrophism and tectonic background of sedimentation; depositional loci; classification of sediments: quartzites, graywackes, arkoses; chemical sediments; paleogeography, paleoclimatology, oil finding. Prerequisite: Min. 511. Concurrent: Min. 514. *Mr. Krynine*
513. METHODS OF ANALYSIS OF SEDIMENTS (3) Principles and practices used in analyzing sedimentary rocks for size, shape, and accessory (heavy) minerals. Concurrent: Min. 511. *Mr. Griffiths*
514. APPLIED SEDIMENTOLOGY (3) Design and control in analysis of sedimentary rocks; application of these techniques to industrial problems. Concurrent: Min. 512. *Mr. Griffiths*
- †517. SEDIMENTS OF THE WORLD (1-9) Microscopic and field studies of representative American and foreign rock suites; correlation with paleogeographic, geotectonic, economic data. Prerequisites: Min. 512, 514. *Mr. Krynine*

\*Credits to be arranged, 2-4 per semester.

†Credits to be arranged, 1-3 per semester.

## MINERALOGY

520. STUDY OF ACCESSORY MINERALS (2-4) Detailed study of accessory (heavy) minerals; their significance in problems of provenance, petrogenesis, mineral stratigraphy, and paleogeography. Prerequisites: Min. 511, 512, 513, 514. *Mr. Griffiths*
521. COLOR IN MINERALS (1-2) Nature of light absorption as a function of chemical composition for solutions, glasses, and minerals. *Mr. Weyl*
524. INTRODUCTION TO SEDIMENTATION (3) Concurrent: Min. 483. *Mr. Krynine*
525. IGNEOUS PETROLOGY (2-6) Origin, distribution, and composition of igneous rocks. Prerequisites: Min. 483, 500, 527; G.G. 513. *Mr. Tuttle*
526. STATISTICAL PROBLEMS IN SEDIMENTARY GEOLOGY (3) Application of experimental design, sampling procedures, multiple regression and discriminant analysis in solving problems in sedimentary petrography. Prerequisites: Min. 514; Math. 410 or Agro. 545. *Mr. Griffiths*
527. IGNEOUS AND METAMORPHIC MINERALOGY (3) Structural and compositional variations of minerals in igneous and metamorphic rocks. *Mr. Smith*
528. MINERALOGICAL CRYSTALLOGRAPHY (2-3) Application of X-ray and morphological crystallography to mineralogy and petrology.
530. (Cer.T. 530). STRUCTURE, PROPERTIES, AND OCCURRENCE OF CLAY MINERALS (2-5) Structure analysis and identification of clay minerals; mineral transformations and behavior; occurrence, genesis, and petrography of fine-grained sediments. *Messrs. Griffiths, Bates, and Brindley*

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in mineralogical studies are listed under Mineral Sciences in Part II of this bulletin.*

## MINING ENGINEERING

HOWARD L. HARTMAN, *Head of the Department of Mining*  
305B Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Hartman and Mitchell; Associate Professor Kochanowsky.

Areas of specialization which may be followed in research and course work include mine property valuation and economics of mining engineering (ore estimation, cost analysis and control, budgeting), mechanization and mine plant (unit operations, materials handling, continuous mining, power supply), development and exploitation methods (mine planning and layout, design of systems), production engineering and operational analysis (time study, standards, job rating, operations research), environmental control (gas and dust technology, ventilation, air conditioning, hygiene, illumination, safety), and rock mechanics (stress analysis, roof and ground control, penetration, fragmentation).

A bachelor's degree in mining engineering or some related engineering field is required for admission to graduate work. Students may be required to make up deficiencies in their area of specialization. Certain basic, related courses outside the department may be approved as part of the major.

MINING (MNG)

- 401. MINE PLANT ENGINEERING I (3)
- 402. MINE PLANT ENGINEERING II (3)
- 411. MINE PRODUCTION ENGINEERING (2)
- 412. MINE MANAGEMENT AND SUPERVISION (2)
- 422. MINE VENTILATION AND AIR CONDITIONING (3)
- 424. MINE SAFETY ENGINEERING (1)
- 431. ROCK MECHANICS (2)
- 451-452. ADVANCED MINING ENGINEERING I and II (1 each)
- 490. SENIOR MINING SEMINAR (1)
  
- 513. MINE COST ANALYSIS (3) Nature of mining costs, their analysis and control: depreciation and depletion, capital and operating costs, budgets, records.
- 514. MINE OPERATIONS ANALYSIS (3) Scientific planning and layout of mining operations based on time studies, mathematical analysis, and proportionality of centroids of reserves. Prerequisites: Math. 44 or 45, Mng. 411.
- 525. DUST TECHNOLOGY (3) Physical and chemical properties of dusts; airborne dust determinations and analysis; dust control applicable to mills and mines. Prerequisite: Mng. 422.
- 526. MINE VENTILATION (3) Airflow in mine openings and its control; network solution by mathematics and computer; design of mine and industrial ventilation systems. Prerequisite: Mng. 422.
- 528. MINE AIR CONDITIONING (3) Thermodynamics of vapor mixtures; heat flow through rock; physiological effects of hot, humid environments; design of temperature-humidity control systems. Prerequisite: Mng. 422.
- 532. ROCK MECHANICS (3) Behavior of rock under static loading; underground stress instrumentation; experimental stress analysis; design of mine openings; theories of subsidence. Prerequisite: Mng. 431.
- 541. THEORY OF ROCK PENETRATION (3) Behavior of rock under dynamic loads intended to penetrate; basic energy relations; application of theory to drilling and other penetration. Prerequisites: Phys. 285, Mng. 38.
- 542. THEORY OF ROCK FRAGMENTATION (3) Behavior of rock under dynamic loads intended to fragment; physical chemistry of explosives; detonation; theory of blasting; design of drill rounds. Prerequisites: Phys. 285, Mng. 38.
- 580. MINING ENGINEERING RESEARCH (1-3 per semester) Supervised research on a specific problem involved in mining science or technology.
- 590. GRADUATE MINING SEMINAR (1 per semester) Preparation and presentation of formal papers on problems of an advanced nature in mining engineering. Required each semester in residence.

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in mining studies are listed under Mineral Sciences in Part II of this bulletin.*



## MUSIC

HUMMEL FISHBURN, *Head of the Department*  
217 Carnegie Building

*Degree Conferred:* M.A.

*Graduate Faculty:* Professors Fishburn, Henninger, and Taylor; Associate Professors Ceiga and Karhan; Assistant Professor Brinsmaid.

In his graduate program a student may emphasize one of the following areas, or may elect a program including work in all of them: theory, performance, music literature, and creative music. The minor must be chosen from the liberal arts. Admission to this graduate program requires completion of a recognized music curriculum.

### MUSIC (MUSIC)

- 407. PIANO LITERATURE (3)
- 408. VOCAL LITERATURE (3)
- 410. MUSIC OF THE 20TH CENTURY (3)
- 411. LITERATURE OF THE VIOLIN (3)
- \*429. SINGER'S STYLE AND INTERPRETATION (3) Fee \$50.
- 456. ELEMENTARY COUNTERPOINT (3)
- 459. MODERN INSTRUMENTAL ARRANGING (3)
- 466. ADVANCED CONDUCTING (3)
  
- \*503. ADVANCED STRINGED INSTRUMENTS (3) Study, repertoire building, and recital performance. Fee \$50.
- \*511. ADVANCED PIANO (3) Piano literature of all periods for public performance. Fee \$50.
- \*531. ADVANCED ORGAN (3) Study, repertoire building, and recital performance. Prerequisite: 4 credits of Music 31 and/or 38. Fee \$60.
- 543. MODERN HARMONY (3) Harmonic writing based on 20th century practices with attention to traditional idioms that serve as foundation.
- 557. SYMPHONIC STRUCTURE (3) Survey of the evolution and application of the forms used in symphony, sonata, concerto, string quartet, and related works. Prerequisite: Music 57.
- \*558. FREE COMPOSITION (3) Composition: vocal and instrumental, standard or modern idioms. Prerequisite: 18 credits in harmony, counterpoint, and piano.
- 563. FREE ARRANGING (3) Correct procedure in arranging for vocal and instrumental ensembles; practical exercises in quartets, glee clubs, and choruses; small instrumental groups, band, and orchestra. Prerequisite: 18 credits in harmony, including 3 of orchestration.
- 567. THE LITERATURE OF THE ORCHESTRA (3) The suite, symphony, tone poem, and overture from the point of view of appreciation, form, and orchestration. Prerequisites: Music 6 and theoretical knowledge of the key instruments of the orchestra.

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\*May be repeated for a total of 12 credits.

# MUSIC EDUCATION

HUMMEL FISHBURN, *Head of the Department*  
217 Carnegie Building

*Degrees Conferred:* D.Ed., M.Ed.

*Graduate Faculty:* Professors Andrews, Dunlop, and Fishburn; Associate Professors Campbell and Karhan.

A student majoring in music education is required to offer a minor in music. However, the master's program must include some work, and the doctoral program considerable work, in the area of general education.

Doctoral students may specialize in vocal, instrumental, or theoretical music in elementary, secondary, or college teaching; but the degree requires work in each of these fields.

For admission to a graduate program a student must have completed a recognized music education curriculum.

## MUSIC EDUCATION (MU ED)

- 446. THE ELEMENTARY MUSIC SPECIALIST (3)
- 462. PEDAGOGY OF THEORY (3)
- 468. THE TEACHING OF PIANO (3)
- 469. BAND AND ORCHESTRA TECHNIQUE (3)
- 470. CHORAL TECHNIQUE (3)
- 475. OBJECTIVES AND PROBLEMS IN ELEMENTARY MUSIC EDUCATION (3)
- 480. CHORAL PROGRAM IN THE SECONDARY SCHOOL (3)
  
- 500. MUSIC EDUCATION SEMINAR (3-6) Problems of various phases of music education, both instrumental and vocal; research and literature dealing with these problems.
  
- 569. PRESENT-DAY TRENDS IN INSTRUMENTAL MUSIC (3) New methods and materials for band, orchestra, and ensembles.
  
- 571. VOCAL PEDAGOGY (3) Detailed study of vocal problems met in public schools, elementary through high school; vocal class pedagogy and literature; daily voice training. Prerequisites: Mu.Ed. 48, teaching experience.
  
- 572. INSTRUMENTAL PEDAGOGY (3-6) Research problems in band and orchestra. Prerequisite: Mu.Ed. 54 or practical experience.
  
- 573. THE MATERIALS OF APPRECIATION (3) Methods and materials for development of music appreciation in elementary and secondary schools. Prerequisites: Music 5, teaching experience.
  
- 574a,b. PRESENT-DAY TRENDS IN MUSIC EDUCATION (3-6) Present-day music education materials and methods (elementary and secondary levels) in relation to modern educational philosophy; emphasis upon practical problems presented by members of the class. Prerequisites: Mu.Ed. 48, teaching experience.
  
- 575. THE JUNIOR HIGH SCHOOL MUSIC CURRICULUM (3) Instructional materials, procedures, curricular and extracurricular activities, integration with other subjects.

## MUSIC EDUCATION

576. MUSIC SUPERVISION (3) Current educational procedures in training music supervisors.
580. FIELD PROJECTS IN JUNIOR AND SENIOR HIGH SCHOOL MUSIC (3) Curricular problems to be carried on under actual school conditions; individual work under supervision. Prerequisites: teaching experience, 30 credits of graduate study.
594. PEDAGOGY OF EAR TRAINING (3) Materials and methods for training the listener to grasp, understand, and write what is heard from melody to four-part harmony. Prerequisite: 12 credits in ear training and/or harmony.

## NUCLEAR ENGINEERING

NUNZIO J. PALLADINO, *Head of the Department*  
402 Sackett Building

*Degrees Conferred:* M.S., M.Eng.

A student may specialize in reactor analysis, nuclear materials, or reactor instrumentation and control. Admission requires a bachelor's degree in engineering or in the physical sciences. Students who have not had appropriate undergraduate courses in nuclear physics and partial differential equations will be required to schedule them.

### NUCLEAR ENGINEERING (N E)

410. NUCLEAR ENGINEERING (3)
411. NUCLEAR ENGINEERING (3)
501. REACTOR ENGINEERING (3) Reactor controls, shielding of nuclear reactors, stress analysis of reactor materials, power cycle analysis, breeding, and advanced design considerations. Prerequisite or concurrent: Phys. 566.
502. REACTOR ENGINEERING LABORATORY (1-5) Reactor experiments devised to acquaint the student with reactor technology. Prerequisite or concurrent: Phys. 566.
503. THERMONUCLEAR ENGINEERING (3) Binary fusion reactions; microscopic and macroscopic phenomena in a completely ionized gas; electromagnetic confinement; design, operation, and diagnostics of experiments. Prerequisite: Math. 452.

### PHYSICAL SCIENCE (PH SC)

501. SEMINAR IN NUCLEAR SCIENCE AND ENGINEERING (0)

## NUTRITION

(See page 106, Foods and Nutrition)



## PETROLEUM AND NATURAL GAS ENGINEERING

ROBERT L. SLOBOD

*Head of the Department of Petroleum and Natural Gas*  
26 Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Nielsen and Slobod; Associate Professors Burcik and Stahl; Assistant Professor Bissey.

Areas of specialization include experimental and theoretical studies of water flooding and the newer methods for displacing oil from porous media, methods for calculating reservoir performance, scaled laboratory studies of reservoir phenomena, and drilling and well completion problems.

Students who expect to enter graduate study in this field with a degree in another curriculum should present 20 credits of chemistry and physics, 6 of geology, 15 of engineering science, and credit for mathematics through integral calculus. A limited number of deficiencies may be made up after admission.

Certain closely related courses outside the department may be counted as petroleum and natural gas credits toward the degree.

### PETROLEUM AND NATURAL GAS (P N G)

- 421. RESERVOIR ENGINEERING (3)
- 431. DRILLING FLUIDS (2)
- 481. NATURAL GAS AND GASOLINE PLANTS (2)
- 485. SECONDARY RECOVERY (3)
- 490. ADVANCED CORE TESTING (3)
  
- 510. FLOW OF HOMOGENEOUS FLUIDS THROUGH POROUS MEDIA (3) Concepts and mathematics describing steady and unsteady state flow in porous media for various initial and boundary conditions.
- \*512. RESERVOIR ENGINEERING (3-6) Applications of the principles of fluid behavior in porous media to the analysis of complex reservoir behavior; log interpretation. Prerequisite: P.N.G. 510.
- 515. SECONDARY RECOVERY (3) Methods of predicting oil recovery by immiscible fluid injection.
- 517. CASE STUDIES OF SECONDARY RECOVERY (1-3) Interpretation and critical analysis of production and injection characteristics of typical water flood operations. Prerequisite: P.N.G. 515 or 485.
- 520. PHASE RELATIONS IN RESERVOIR ENGINEERING (3) Phase relations as applied to condensate and retrograde condensate reservoirs and to other problems in petroleum production.
- 525. SPECIAL TOPICS IN PETROLEUM ENGINEERING (2-6)

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\*Credits to be arranged, 3 per semester.

## PETROLEUM AND NATURAL GAS

530. NATURAL GAS ENGINEERING (1-3) Flow in producing or storage reservoirs; gas well testing; transmission systems; storage cycles; current developments. Prerequisite: P.N.G. 481.

†535. SEMINAR (1-3)

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in petroleum and natural gas studies are listed under Mineral Sciences in Part II of this bulletin.*

## PHILOSOPHY

JOHN M. ANDERSON, *Head of the Department*  
119 Sparks Building

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Professors Anderson, Finch, Freund, and Mourant; Associate Professors Johnstone and Pape.

A student may concentrate on history of philosophy, logic and scientific methods, or value theory. Undergraduate preparation should include a major in philosophy, but a strong minor may also be acceptable.

### PHILOSOPHY (PHIL)

- 406. MEDIEVAL PHILOSOPHY (3)
- 410. STUDIES IN GREEK PHILOSOPHY (3-6)
- 411. STUDIES IN MODERN PHILOSOPHY (3-6)
- 414. AESTHETIC THEORY (3)
- 417. NINETEENTH CENTURY PHILOSOPHY (3)
- 418. RECENT AND CONTEMPORARY PHILOSOPHY (3)
- 419. PHILOSOPHICAL BACKGROUNDS OF AMERICAN THOUGHT (3)
- 425. PHILOSOPHY OF LAW (3)
- 426. METAPHYSICS (3)
- 427. ADVANCED ETHICS (3)
- 428. (Math. 428). LOGICAL THEORY (3)
- 429. SEMANTICS: PHILOSOPHY OF LANGUAGE AND SYMBOLISM (3)
- 430. PHILOSOPHICAL PROBLEMS (3-6)
  
- 500. ETHICS: HISTORICAL AND SYSTEMATIC (2-6) Critical study of some phase of ethical theory, or of some period of the history of ethics.
- 504. SOCIAL AND POLITICAL PHILOSOPHY (3) Critical study of basic problems in their historical and functional setting.
- 505. IDEALS OF WESTERN CIVILIZATION (3) Analysis of contemporary ideals in terms of their Graeco-Judean bases.

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†Credits to be arranged, 1 per semester.

- 506. SEMINAR IN ANCIENT PHILOSOPHY (3-6) Study of one or more important men or movements in ancient philosophy.
- 507. SEMINAR IN MEDIEVAL PHILOSOPHY (3-6) Study of one or more important men or movements in medieval philosophy.
- 508. SEMINAR IN MODERN PHILOSOPHY (3-6) Men and movements in philosophy from the Renaissance through the 19th century.
- 509. SEMINAR IN CONTEMPORARY PHILOSOPHY (3-6) Men and movements in 20th century philosophy.
- 510. CLASSICS OF SCIENTIFIC METHOD (3-6) Actual reasoning and procedures of historical masters of scientific methods.
- 511. PRINCIPLES OF EXPERIMENTAL INFERENCE (3-6) Science as controlled inquiry; types of scientific procedures in formal, physical, and sociocultural science.
- 515. PHILOSOPHICAL METHOD (3) Methods proposed by classical and contemporary thinkers for reaching philosophical conclusions: deductive, inductive, dialectical, pragmatic, intuitive.
- 530. PHILOSOPHY RESEARCH SEMINAR (3-6) Study of selected philosophical problems with an emphasis on techniques of philosophical research.
- 550-551. (Math. 550-551). MATHEMATICAL LOGIC (3 each) The logical basis of mathematics and its ultimate nature. Prerequisite: Math. 471, or Phil. (Math.) 428.
- 554. (Math. 554). METAMATHEMATICS (3) Prooftheoretic and modeltheoretic study of systems: Gödel's theorem, relative and absolute consistency proofs, decidability, properties of relational structures, mathematical applications. Prerequisite: Phil. (Math.) 428.

## PHYSICAL EDUCATION

JOHN D. LAWOTHER

*Associate Dean of the College of Physical Education and Athletics*  
246 Recreation Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Bedenk, Conger, Coombs, Davis, Gross, Harnett, Lawther, Speidel, and Thiel; Associate Professor Lucey.

Areas of specialization include: (1) history, philosophy, and principles; (2) applied science (physiology of exercise, kinesiology, body mechanics); (3) organization and administration; (4) objectives, programs, methods, and evaluation; (5) adaptives and correctives; (6) health; and (7) athletics, intramural and interschool. The master's candidate is expected to acquire a basic minimum of knowledge in each of these areas with little specialization except for his thesis or problem. The doctoral candidate is expected to focus on one area during his final year of graduate work.

The requirements for admission to the M.Ed. program are 24 semester hours in professional health and physical education and 24 in education and psychology,



## PHYSICAL EDUCATION

including general psychology, educational psychology, principles and methods of teaching, education electives, and practice teaching.

The requirements for admission to the M.S. program are 36 semester hours in professional health and physical education and 18 in education and psychology. An excellent background in the biological and physical sciences may satisfy up to half of the requirement in professional health and physical education.

### PHYSICAL EDUCATION (PH ED)

441. ADVANCED COACHING OF ATHLETICS FOR MEN (1 per unit)  
Unit A. *Basketball* (1) Unit G. *Swimming* (1)  
Unit B. *Football* (1) Unit H. *Gymnastics* (1)  
Unit C. *Track and Field* (1) Unit I. *Boxing* (1)  
Unit D. *Baseball* (1) Unit J. *Lacrosse* (1)  
Unit E. *Wrestling* (1) Unit K. *Fencing* (1)  
Unit F. *Soccer* (1)
449. ADVANCED TEACHING OF SPORTS AND RHYTHMICS (1 per unit)  
Unit A. *Soccer and Speedball* (1) Unit H. *Early American Country  
Dancing and Social Danc-  
ing* (1)  
Unit B. *Basketball* (1)  
Unit C. *Field Hockey* (1)  
Unit D. *Archery* (1) Unit I. *Tennis* (1)  
Unit E. *Swimming* (1) Unit J. *Badminton* (1)  
Unit F. *Rhythmics for Children* (1) Unit K. *Golf* (1)  
Unit G. *Modern Dance and Accom-  
paniment* (1)
452. ANALYSIS OF PHYSICAL EDUCATION ACTIVITIES FOR THE ELEMENTARY SCHOOL (3)
453. ANALYSIS OF PHYSICAL EDUCATION ACTIVITIES FOR THE HIGH SCHOOL (3)
454. THE NATURAL PROGRAM OF PHYSICAL EDUCATION ACTIVITIES, APPLIED (3)
455. SCIENTIFIC METHOD IN HEALTH AND PHYSICAL EDUCATION (3)
460. METHODS AND PRINCIPLES OF ATHLETIC COACHING (3)
480. ADVANCED ANATOMY AND PHYSIOLOGY, APPLIED (3)
489. INTRAMURAL ATHLETICS (3)
490. INTRODUCTION TO TESTS AND MEASUREMENTS IN HEALTH AND PHYSICAL EDUCATION (3)
491. ORGANIZATION AND ADMINISTRATION OF HEALTH AND PHYSICAL EDUCATION IN SCHOOLS (3)
500. PROBLEM IN PHYSICAL EDUCATION (3) Prerequisite: Ph.Ed. 455.
522. ORGANIZATION AND ADMINISTRATION OF PHYSICAL EDUCATION IN COLLEGES AND UNIVERSITIES (3) Administration of physical education in college; credits, schedules, excuses, records, reports, budgets, classification, tests, staff, and facilities. Prerequisite: Ph.Ed. 491.
523. ADMINISTRATION OF COLLEGE ATHLETICS (3) Eligibility, schedules, managerial systems, relationships of athletics to the physical education program and to education in general. Prerequisite: Ph.Ed. 491.
526. ATHLETIC PROBLEMS IN SCHOOLS (3) Practical problems which result from administration of athletics in schools. Reports on some aspects of athletics required. Prerequisite: Ph.Ed. 460.
528. PROFESSIONAL EDUCATION OF TEACHERS OF HEALTH AND PHYSICAL EDUCATION (3) Health and physical education surveys, publicity, sociability and personality tests, legislation, state certification, standards for facilities and equip-

## PHYSICAL EDUCATION

- ment, in-service, follow-up, and teacher-community problems. Prerequisite: Ph.Ed. 491.
529. SUPERVISION OF PHYSICAL EDUCATION IN SCHOOLS (3) Methods and policies of the school supervisor of physical education; conferences, planning and presenting the program, evaluating results, improving teachers-in-service, supervision of the classroom teacher. Prerequisite: Ph.Ed. 491.
530. RESEARCH TECHNIQUES IN HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (3) Prerequisite: Ph.Ed. 490.
531. RESEARCH IN HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (3) Prerequisite: Ph.Ed. 530.
532. TESTS AND MEASUREMENTS IN PHYSICAL EDUCATION (3) Critical study of tests and measurements available in physical education; methods of constructing and evaluating new tests and measurements. Prerequisite: Ph.Ed. 490.
534. STUDIES IN CURRICULUM CONSTRUCTION IN PHYSICAL EDUCATION (3) Principles and methods of curriculum building in physical education; different psychological and educational points of view, organizing a course of study committee, making units of instruction. Prerequisite: Ph.Ed. 454.
535. MODERN FOREIGN SYSTEMS OF PHYSICAL EDUCATION (3) Comparative analysis of national and local programs and systems of physical education in foreign countries. Prerequisites: Ph.Ed. 534, 595.
536. SCIENTIFIC METHODS IN ATHLETIC COACHING (3) Unusual techniques in athletic coaching which are not commonly recognized and used; advanced skills and strategy in coaching major sports. Prerequisite: Ph.Ed. 460.
550. SEMINAR IN HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (1-6)
555. RELATIONSHIPS OF PHYSICAL EDUCATION TO THE EXACT SCIENCES (3)
560. ADMINISTRATIVE PROBLEMS OF PHYSICAL EDUCATION IN SCHOOLS (3) Solutions to problems emerging from the administration of physical education in schools, fitting physical education into the school's schedule, awards and budgets. Prerequisite: Ph.Ed. 491.
581. PROBLEMS IN BODY MECHANICS (3) Certain aspects of human motion and body segmental alignment; analysis of human gait, and the dynamic adaptation of the spine, thorax, and pelvis to external physical forces. Prerequisites: Hl.Ed. 244, Ph.Ed. 399.
595. PHILOSOPHY OF HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (3) Prerequisite: Hl.Ed. 453 or Ph.Ed. 491 or Rc.Ed. 465.

## PHYSICAL SCIENCE

HENRY W. KNERR

*Chairman of the Committee on Physical Science*  
104 Willard Building

*Degrees Conferred:* D.Ed., M.Ed.

The M.Ed. program, which is designed to meet the needs of secondary school science teachers, consists of at least 24 credits chosen from chemistry, geology,

## PHYSICAL SCIENCE

mathematics, and physics and a minor of at least 6 credits in educational foundations. A candidate is expected to complete at least one course in each of the four sciences and at least 12 credits in one of them.

As a minimum requirement for admission a student is expected to have had 10 credits in chemistry, 8 credits in physics, mathematics through trigonometry, and 18 credits in education, including educational psychology and practice teaching.

## PHYSICS

JOHN A. SAUER, *Head of the Department*  
101 Osmond Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Gibbons, Knerr, Müller, Pepinsky, Rank, Sauer, Schilling, Webb, and White; Associate Professors Ackerman, Bauer, Blanchard, Burnett, Fitzgerald, Myers, Okaya, Rix, Stoner, Vand, Weber, and Wiggins; Assistant Professors Bakamjian, Baker, Donahue, McCubbin, Pratt, Roy, Winter, Woodward, and Work.

Graduate instruction and research opportunities are available in visible and infrared spectroscopy, crystal structure, solid state, field emission, acoustics, high-pressure physics, biophysics, electronics, shock waves, low-temperature physics, nuclear physics, physics of high polymers, and various phases of theoretical physics.

A bachelor's degree in physics or an allied field is required for admission. Students who lack some of the usual upper-class undergraduate courses in physics may be requested to take additional course work without degree credit.

### PHYSICS (PHYS)

- 400. INTERMEDIATE ELECTRICITY AND MAGNETISM (4)
- 402. ELECTRONICS (4)
- 404. ELECTRONIC MEASUREMENTS (2-4)
- 406. NUCLEAR PHYSICS (3)
- 411. THEORETICAL MECHANICS (3)
- 412. THEORY OF THE SOLID STATE (3)
- 417. THE TEACHING OF PHYSICS (3)
- 420. INTERMEDIATE HEAT (3)
- 433. MECHANICS AND FLUID PHYSICS FOR TEACHERS (3)
- 435. ELECTRICITY AND MAGNETISM FOR TEACHERS (3)
- 436. OPTICS FOR TEACHERS (3)
- 437. HEAT, WAVE MOTION, AND SOUND FOR TEACHERS (3)
- 439. ELEMENTARY SURVEY OF MODERN PHYSICS FOR TEACHERS (3)
- 441. DEMONSTRATION EXPERIMENTS FOR TEACHERS (3)
- 443. INTERMEDIATE ACOUSTICS (3)
- 444. MEASUREMENTS IN ACOUSTICS (2)
- 454. ATOMIC AND NUCLEAR PHYSICS (3)
- 456. ATOMIC AND NUCLEAR PHYSICS (3)
- 457. EXPERIMENTAL ATOMIC PHYSICS (2)
- 458. INTERMEDIATE OPTICS (4)



- 461. THEORETICAL MECHANICS (3)
- 467. INTERMEDIATE ELECTRICITY AND MAGNETISM (3)
- 470. SPECIAL TOPICS (1-9)
- 473-474. BIOPHYSICS (3 each)
- 477. X-RAY ANALYSIS OF SOLIDS AND LIQUIDS (3)
  
- 507. THERMODYNAMICS AND KINETIC THEORY (3) Classical and modern thermodynamics; introduction to statistical mechanics.
- 509. PHYSICS SEMINAR (1-3 per semester) Topics from current research.
- 512-513. SOLID STATE PHYSICS (3 each) Analytical treatment of physical properties of solids: crystal structure, X-ray diffraction, lattice vibrations, paramagnetism, ferromagnetism, ferroelectricity; electron theory of metals, semiconductors. Prerequisite: Phys. 530.
- 517. STATISTICAL MECHANICS (3) Classical and quantum statistics, theory of ensembles, degenerate gases, applications to low temperature effects and cooperative phenomena. Prerequisites: Phys. 507, 561.
- 521. CRYSTAL STRUCTURE (3) Crystal symmetry, X-ray scattering, theory and techniques of crystal structure determination.
- 522. ADVANCED CRYSTAL ANALYSIS (3) Phase-determining methods in crystal analysis.
- 530. THEORETICAL MECHANICS (4) Newtonian mechanics; Lagrange's equations, Hamilton's principle; Hamilton's equations; coupled systems; waves in strings, central field problem; rigid bodies; elasticity; hydrodynamics.
- 532. ADVANCED THEORETICAL MECHANICS (3) Least action principle; canonical transformation; Lagrange and Poisson brackets; Hamilton-Jacobi equations; classical theory of fields. Prerequisite: Phys. 530.
- 533. THEORETICAL ACOUSTICS (3) Vibrating systems; transmission of disturbances through elastic and visco-elastic media. Prerequisite: Phys. 530.
- 553-554. NUCLEAR PHYSICS (3 each) Discussion and theoretical interpretation of basic experiments involving atomic nuclei and nuclear radiations. Prerequisite: Phys. 562.
- 557. ELECTRICITY AND MAGNETISM (3) Electro- and magnetostatics, Maxwell's equations, boundary value problems, electric and magnetic properties of material media.
- 558. ADVANCED ELECTRICITY AND MAGNETISM (3) Energy and momentum in the field, radiation theory, classical relativistic electron theory. Prerequisite: Phys. 557.
- 560. RESEARCH PROBLEMS (1-18) Introduction to research through individual assignments.
- 561-562. QUANTUM MECHANICS (3 each) The basic theory of wave and matrix mechanics, approximation methods, applications. Prerequisite: Phys. 530.
- 565. REACTOR ANALYSIS (4) Physical principles and mathematical methods of reactor analysis. Prerequisite: Phys. 406.

## PHYSICS

566. REACTOR ANALYSIS (3) Continuation of Phys. 565. Prerequisite: Phys. 565.
571. ATOMIC PHYSICS (3) Experimental basis of modern physics; atomic spectra and structure, nuclear phenomena.
572. SELECTED TOPICS IN SPECTROSCOPY (3) Atomic and molecular spectra, experimental methods and theoretical analyses.
575. SPECIAL TOPICS (1-3 per semester) Theoretical studies in any field of modern physics with or without associated experimental work. Prerequisite: Phys. 456.

## PLANT PATHOLOGY

J. E. LIVINGSTON

*Head of the Department of Botany and Plant Pathology*  
206 Buckhout Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Lewis, Livingston, Mills, and Wernham; Associate Professors Boyle, Fergus, Graham, and Kneebone; Assistant Professors Bloom, Couch, Schein, Stambaugh, and Tammen.

A student may specialize in the study of plant diseases caused by fungi, bacteria, or viruses, and/or in their control, especially by plant breeding or by chemical means.

For admission a student must present at least 27 credits in botany, plant pathology, and biological science, of which not more than 6 may be in biological science. As many as 6 credits may be made up as undergraduate deficiencies after the candidate has been admitted to the Graduate School.

See also courses listed under botany, especially Bot. 419, 421, 501, 522, 523, and 526.

### PLANT PATHOLOGY (P PATH)

404. DISEASES OF FIELD AND FORAGE CROPS (3) *Messrs. Schein and Couch*
408. PLANT PATHOLOGICAL TECHNIQUES (3) *Mr. Bloom*
412. ADVANCED FOREST PATHOLOGY (3) *Mr. Fergus*
425. DISEASES OF ORNAMENTAL AND FLORICULTURAL PLANTS (3) *Mr. Tammen*
428. DISEASES OF FRUIT AND VEGETABLE CROPS (3) *Mr. Bloom*
501. CLINICAL PLANT PATHOLOGY (3) Advanced course in diagnostic techniques to acquaint the students with specialized procedures for field and laboratory identification of plant diseases. Prerequisites: P.Path. 10, 408, Bot. 419.
509. PRINCIPLES OF PLANT INFECTION (3) Physiological processes of plant pathogenic bacteria and fungi occurring during incubation, ingress, and infection. Prerequisites: P.Path. 10 or 11, Bot. 419. Spring semester, odd years. *Mr. Schein*
515. DISEASE RESISTANCE IN PLANTS (2-4) Stability of resistance, selection of resistant material, economics of control, special problems. Prerequisites: Bot. 22 or 33, P.Path. 10. Fall semester, odd years. *Messrs. Wernham and Mills*

## PLANT PATHOLOGY

519. VIRUS DISEASES OF PLANTS (3) Nature, symptomatology, transmission, and control of virus diseases of plants. Fall semester, even years. *Mr. Boyle*
520. PLANT PATHOGENIC BACTERIA (3) Bacteria causing plant diseases; methods of identification, inoculation, and control. Spring semester, odd years. *Mr. Kneebone*
530. PLANT DISEASE CONTROL (3) Methods, and laboratory and field testing of materials used in plant disease control. Spring semester, even years.
531. PLANT PATHOLOGY SEMINAR (1 per semester) Selected topics of current research, history, and contemporary trends in plant pathology.

## POLITICAL SCIENCE

M. NELSON McGEARY, *Head of the Department*  
129 Sparks Building

*Degrees Conferred:* Ph.D., M.A., M.P.A.

*Graduate Faculty:* Professors Atwater, Brewster, Ferguson, and McGeary; Associate Professors Aspaturian, Riemer, and Silva; Assistant Professors Law and Sorauf.

Students may specialize in American government, political theory, international relations, or comparative government. The Master of Public Administration degree program is built around PL.Sc. 560, 561, and 562 (See page 44).

For admission to graduate work students should present at least 12 credits of undergraduate work in the field, or its equivalent.

### POLITICAL SCIENCE (PL SC)

- |                                                                       |                                              |
|-----------------------------------------------------------------------|----------------------------------------------|
| 401. POLITICAL BEHAVIOR (3)                                           | <i>Mr. Sorauf</i>                            |
| 411. AMERICAN POLITICAL THEORY (3)                                    | <i>Mr. Riemer</i>                            |
| 413. GOVERNMENT AND POLITICS OF THE SOVIET UNION (3)                  | <i>Mr. Atwater</i>                           |
| 414. FOREIGN POLICY OF THE SOVIET UNION (3)                           | <i>Mr. Aspaturian</i>                        |
| 415. INTERNATIONAL ORGANIZATION (3)                                   | <i>Mr. Aspaturian</i>                        |
| 416. INTERNATIONAL LAW (3)                                            | <i>Mr. Aspaturian</i>                        |
| 417. MUNICIPAL GOVERNMENT (3)                                         |                                              |
| 419. PUBLIC ADMINISTRATION (3)                                        | <i>Mr. McGeary</i>                           |
| 421. MODERN POLITICAL THEORY (3)                                      | <i>Mr. Riemer</i>                            |
| 424. STATE GOVERNMENT IN THE UNITED STATES (3)                        |                                              |
| 426. POLITICAL PARTIES (3)                                            | <i>Miss Silva</i>                            |
| 427. PUBLIC OPINION AND PROPAGANDA (3)                                | <i>Miss Silva</i>                            |
| 428. PENNSYLVANIA LOCAL GOVERNMENT (3)                                |                                              |
| 429. PENNSYLVANIA LOCAL ADMINISTRATION (3)                            |                                              |
| 431. ANCIENT AND MEDIEVAL POLITICAL THEORIES (3)                      | <i>Mr. Riemer</i>                            |
| 432. CURRENT POLITICAL TRENDS AND PROBLEMS IN THE UNITED STATES (3-9) |                                              |
|                                                                       | <i>Messrs. Riemer and Sorauf, Miss Silva</i> |
| 433. THE LAW OF LABOR-MANAGEMENT RELATIONS (3)                        | <i>Mr. Brewster</i>                          |
| 442. AMERICAN FOREIGN POLICY (3)                                      | <i>Mr. Atwater</i>                           |
| 444. GOVERNMENT REGULATION (3)                                        | <i>Mr. Ferguson</i>                          |



## POLITICAL SCIENCE

445. ADMINISTRATIVE LAW (3) *Mr. Brewster*  
446. JUDICIAL SYSTEMS (3) *Mr. Law*  
451. COMPARATIVE GOVERNMENT (3)  
456. GOVERNMENTS AND FOREIGN POLICIES OF LATIN AMERICA (3) *Mr. Law*  
458. GOVERNMENTS AND FOREIGN POLICIES OF THE FAR EAST (3) *Mr. Aspaturian*  
499. FOREIGN STUDY IN GOVERNMENT (2-6)  
500. SEMINAR IN POLITICAL SCIENCE (3-12) Subject to be announced. *Mr. Brewster*  
505. SEMINAR IN ADVANCED AMERICAN GOVERNMENT (3-12)  
508. RESEARCH IN PUBLIC ADMINISTRATION (3-12) *Mr. McGeary*  
509. RESEARCH TECHNIQUES IN POLITICAL SCIENCE (3) *Miss Silva*  
510. POLITICAL AND ADMINISTRATIVE PROBLEMS IN PENNSYLVANIA (3-6) *Mr. McGeary*  
512. COMPARATIVE GOVERNMENT (3-12) *Mr. Atwater, Miss Silva*  
515. INTERNATIONAL RELATIONS (3-6) *Mr. Atwater*  
517. INTERNATIONAL ORGANIZATION (3-6) *Mr. Aspaturian*  
519. PUBLIC ADMINISTRATION (3-6) *Mr. McGeary*  
521. POLITICAL THEORY (3-6) *Mr. Riemer*  
535. GOVERNMENT REGULATION (3-6)  
560. PUBLIC MANAGEMENT I (15) Organization, management, personnel, budgeting, accounting, and other fiscal procedures in government at all levels.  
561. PUBLIC MANAGEMENT II (15) Administrative law, communications and report writing, statistics, public relations, public works administration, and planning in government at all levels. Prerequisite: Pl.Sc. 560.  
562. PUBLIC MANAGEMENT III (6) Supervised internship and report. Prerequisite: Pl.Sc. 561.

## POULTRY HUSBANDRY

ARTHUR J. G. MAW, *Head of the Department*  
103 Weaver Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Bressler, Margolf, Maw, and Murphy; Associate Professors Buss, Hale, and Mueller; Assistant Professor Schein.

Students may specialize in poultry nutrition, poultry management, poultry products, poultry breeding, or animal behavior. In each area the program consists of a joint major between the Department of Poultry Husbandry and one or more

## POULTRY HUSBANDRY

basic science departments. Admission requirements vary according to the area of specialization. Students with undergraduate majors in the basic sciences may qualify.

Excellent facilities are available for research in production, processing, and preservation of market eggs and dressed poultry, and in chick and poult nutrition. A specially designed and equipped Solar Laying House also provides facilities for investigation of production and behavioral problems encountered in large, concentrated populations of layers.

### POULTRY HUSBANDRY (P H)

401. (Psy. 401, Zool. 401). ANIMAL BEHAVIOR (3) *Mr. Hale*  
412. POULTRY BREEDING (3) *Mr. Buss*
502. ADVANCED POULTRY NUTRITION (2-4) Prerequisite: P.H. 3. *Mr. Murphy*  
503. ADVANCED POULTRY FARM MANAGEMENT (2-4) Prerequisite: P.H. 8. *Mr. Bressler*  
504. ADVANCED MARKET POULTRY AND EGGS (2-4) Prerequisites: P.H. 1, 7; Ag.Ec. 33 or 2 additional credits in poultry husbandry. *Messrs. Margolf and Mueller*  
505. RESEARCH IN POULTRY HUSBANDRY (1-15 per semester) Prerequisite: 9 credits in poultry husbandry.  
506. SEMINAR IN POULTRY HUSBANDRY (1-6)  
582. (Psy. 582, Zool. 582). RESEARCH IN ANIMAL BEHAVIOR (2-6 per semester) Research in special areas of animal behavior involving field or laboratory work. Prerequisite: P.H. (Psy., Zool.) 401; or Psy. 403. *Messrs. Hale and Schein*

## PSYCHOLOGY

ARTHUR H. BRAYFIELD, *Head of the Department*  
112 Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Adams, Bernreuter, Brayfield, Carpenter, Corso, Grosslight, Guest, Hall, Harris, Lepley, Smith, Snyder, and VanOrmer; Associate Professors Gorlow, Guthrie, Hale, Ray, Siegel, Thevaos, and Whaley; Assistant Professors Ashby, Ford, Hoffman, Jackson, Piers, Prokasy, Stover, and Urban.

Areas in which a student may specialize are: (1) clinical psychology, which includes professional training for mental hygiene clinics, colleges, and institutions; (2) educational and developmental psychology, which prepares for college teaching, teacher education, and educational clinics; (3) experimental and general psychology, which prepares for college teaching and for academic and professional specialties; (4) school psychology, which prepares for work in the public schools and for the Pennsylvania State Certificate as a Public School Psychologist; (5) industrial and business psychology, which prepares for positions in the application of

## PSYCHOLOGY

psychology to business, industry, institutions, and state and federal agencies; (6) social psychology, which prepares for college teaching, work in applied social psychology—group dynamics, delinquency, attitude studies, and communications; and (7) psychological measurements and statistics, which provide basic skills for college teaching, work in admission and evaluation programs, test publishing organizations, state and federal agencies, and for most of the areas listed above.

The Penn State Anechoic Chamber provides an exceptional facility for research in hearing for students in experimental and industrial psychology. The Psychology Clinic offers unique training in the clinical and counseling areas. Closed-circuit television facilities also enable interested students to gain experience with research in teaching and the use of this medium.

Requirements for admission include a broad undergraduate preparation, a junior-senior scholastic average of approximately B, a minimum of 12 credits in psychology, and a satisfactory graduate student rating on a scholastic aptitude examination. Applicants with a master's degree will have their admission evaluated with emphasis on the quality of their graduate program.

### PSYCHOLOGY (PSY)

- |                                                                         |                                      |
|-------------------------------------------------------------------------|--------------------------------------|
| 400. HONORS COURSE IN PSYCHOLOGY (2-6)                                  |                                      |
| 401. (P.H. 401, Zool. 401). ANIMAL BEHAVIOR (3)                         | <i>Mr. Hale</i>                      |
| 403. INTRODUCTORY PHYSIOLOGICAL PSYCHOLOGY (3)                          | <i>Mr. Slivinske</i>                 |
| 411. PSYCHOLOGY OF THE PRESCHOOL CHILD (3)                              | <i>Mr. Whaley</i>                    |
| 412. ABNORMAL PSYCHOLOGY (3)                                            | <i>Mr. Guthrie</i>                   |
| 414. INTERMEDIATE EDUCATIONAL PSYCHOLOGY (2-3)                          | <i>Mr. Thevaos</i>                   |
| 415. INTERMEDIATE STATISTICS IN PSYCHOLOGY AND EDUCATION (3)            | <i>Mr. Ray</i>                       |
| 417. SOCIAL PSYCHOLOGY (2-3)                                            | <i>Mr. Carpenter</i>                 |
| 418. MEASUREMENT OF PERSONALITY (3)                                     | <i>Mr. Jackson</i>                   |
| 419. GUIDANCE AND EDUCATION IN SEXUAL AND MARITAL ADJUSTMENT (3)        | <i>Mr. Adams</i>                     |
| 420. APPLIED SOCIAL PSYCHOLOGY (3)                                      |                                      |
| 422. PSYCHOLOGICAL METHODS OF MEASURING THE REACTIONS OF THE PUBLIC (3) | <i>Mr. Guest</i>                     |
| 423. TEST CONSTRUCTION AND STANDARDIZATION (2-3)                        | <i>Mr. Ray</i>                       |
| 425. PSYCHOLOGY OF THE ELEMENTARY SCHOOL CHILD (2-3)                    | <i>Mr. Whaley</i>                    |
| 426. ADOLESCENCE (2-3)                                                  | <i>Mr. Harris</i>                    |
| 427. PSYCHOLOGICAL PRINCIPLES IN ADVERTISING (3)                        | <i>Mr. Guest</i>                     |
| 428. OPINION RESEARCH LABORATORY (3)                                    | <i>Mr. Guest</i>                     |
| 429. PSYCHOLOGY OF COMMUNICATION (3)                                    |                                      |
| 431. INDUSTRIAL PSYCHOLOGY (3)                                          | <i>Mr. Smith</i>                     |
| 432. INTRODUCTORY ENGINEERING PSYCHOLOGY (3)                            | <i>Mr. Corso</i>                     |
| 433. PSYCHOLOGY OF OCCUPATIONAL BEHAVIOR (2)                            |                                      |
| 436. MENTAL HYGIENE IN SCHOOLS (3)                                      | <i>Mr. Gorlow</i>                    |
| 437. PSYCHOLOGY OF ADJUSTMENT (3)                                       | <i>Messrs. Gorlow and Grosslight</i> |
| 438. THEORY OF PERSONALITY (3)                                          | <i>Mr. Jackson</i>                   |
| 440. PSYCHOLOGY PROJECTS (1-6)                                          |                                      |
| 441. INDUSTRIAL MOTIVATION AND MORALE (3)                               | <i>Mr. Stover</i>                    |
| 445. (C.D.F.R. 445). DEVELOPMENT THROUGHOUT ADULTHOOD (3)               |                                      |
| 450. MEASUREMENT OF ABILITIES (3)                                       | <i>Mr. Stover</i>                    |
| 474. PSYCHOLOGY OF EXCEPTIONAL CHILDREN (3)                             |                                      |
| 482. INTRODUCTION TO CLINICAL PSYCHOLOGY (3)                            |                                      |



## PSYCHOLOGY

500. SEMINAR: INTRODUCTION TO GRADUATE STUDY (0) For all new graduate students in psychology. *Mr. Brayfield*
501. ADVANCED PSYCHOLOGY (3) Comprehensive study of general psychology. Prerequisite: 9 credits in psychology. *Mr. Lepley*
502. ADVANCED EDUCATIONAL PSYCHOLOGY (2-4) Psychological theories and principles underlying educational theories and practices. Prerequisites: Psy. 14 or 414; practice teaching or teaching experience. *Messrs. Thevaos and Whaley*
503. PHYSIOLOGICAL PSYCHOLOGY (2-6) Correlations between structure and function of nervous system and human consciousness; laws and theories in fields of sensation, attention, association, affection, and thought. Prerequisite: 9 credits in psychology. *Mr. Slivinske*
504. COMPARATIVE PSYCHOLOGY (2-4) Behavior from standpoint of phylogenetic growth and development; biological implications; comparison of different types of animals, including man. Prerequisite: 9 credits in psychology. *Mr. Hale*
505. RESEARCH PROBLEMS IN PSYCHOLOGY (1-15) Prerequisite: 12 credits in psychology.
509. ADVANCED THEORY OF LEARNING AND HABIT FORMATION (2-3) Critical evaluation of major theories of learning: Hull, Guthrie, Tolman, Lewin. Application of learning theory to major problems in psychology. Prerequisite: Psy. 4 or 414. *Mr. Grosslight*
510. HISTORY OF PSYCHOLOGY (3) Theoretical systems, experiments, and personalities in development of modern psychology until about 1920. Prerequisite: 9 credits in psychology. *Mr. Corso*
511. CONTEMPORARY AMERICAN PSYCHOLOGY (2-3) Current systems or schools of psychology with comparative study and critical analysis; points of view as presented by recognized leaders. Prerequisite: 9 credits in psychology. *Mr. Hall*
513. EDUCATIONAL PSYCHOLOGY: DIFFERENTIAL (3) Causes of differences in achievement and personality; psychological implications of methods used by schools in adjusting to individual differences. Prerequisites: Psy. 14 or 414; 6 credits at 400 level in psychology. *Mr. VanOrmer*
514. EDUCATIONAL PSYCHOLOGY: LEARNING (2) Experimentally determined facts about the learning process; synthesis of main theories of learning; application of principles related to: motivation, practice, retention, transfer, meaning, and problem solving. Prerequisites: Psy. 14 or 414; 6 credits at 400 level in psychology.
515. ADVANCED STATISTICS IN PSYCHOLOGY AND EDUCATION (3) Correlation theory and methods, discriminant function, and factor analysis; applications to mental test theory. Prerequisite: Psy. 415 or Ed.Ser. 590. *Mr. Siegel*
516. THEORIES OF DECISION-MAKING (3) Theoretical models and experimental evidence concerning choice behavior, strategies, and values, under riskless conditions and under uncertainty and risk.

## PSYCHOLOGY

517. PSYCHOLOGY OF ATTITUDES AND OPINIONS (3) Acquisition and control of attitudes and opinions, including beliefs, convictions, biases, prejudices, and ideologies as determinants of action. Prerequisite: 18 credits in psychology, including Psy. 417, 422, 437.
518. PROJECTS IN EXPERIMENTAL PSYCHOLOGY (2-4) Individual experimental projects; seminars on experimental design and instrumentation.
522. SURVEY RESEARCH TECHNIQUES (3) Sample and questionnaire designs for investigation of consumer reactions and social issues, and appropriate analytic procedures. Prerequisite: 3 credits in statistics. *Mr. Guest*
525. SAMPLING DESIGNS IN MARKET AND OPINION RESEARCH (3) Techniques in selection of samples for accurate representation of human populations; special emphasis on probability sampling. Prerequisite: 3 credits in statistics. *Mr. Guest*
527. STATISTICAL INFERENCE AND EXPERIMENTAL DESIGN (3) Probability theory, sampling distributions, analysis of variance and covariance, analysis of trend, nonparametric statistics, experimental design. Prerequisite: Psy. 415 or Ed.Ser. 590. *Mr. Ray*
528. OPINION RESEARCH ADMINISTRATION (3-6) Practicum in planning, development of techniques, and administration of the sample survey. Prerequisites: Psy. 15, 21, 422. *Mr. Guest*
529. (C.D.F.R. 529). SEMINAR IN CHILD DEVELOPMENT (1-6) Readings and reports on recent findings in child development. Prerequisite: 6 credits in child development or 6 in educational or child psychology, plus 3 in statistics.
534. ADVANCED ENGINEERING PSYCHOLOGY (3) Experimental studies of psychological factors affecting design and operation of machines. Prerequisites: Psy. 3 and 4, or Psy. 432 or 501. *Mr. Corso*
535. HUMAN DEVELOPMENT (2-3) Psychological phases of human development throughout the life span; implications for school, community, and home. Prerequisite: 9 credits in psychology. *Messrs. VanOrmer and Whaley*
536. RESEARCH METHODS AND PROBLEMS IN EDUCATIONAL AND DEVELOPMENTAL PSYCHOLOGY (1-6) Prerequisites: Psy. 414 or 514; Ed.Ser. 490 or Psy. 415. *Mr. Harris*
537. SEMINAR IN INDUSTRIAL PSYCHOLOGY (3) Prerequisite: Psy. 431. *Mr. Smith*
538. PSYCHOLOGY OF PERSONNEL DEVELOPMENT (3) Industrial training in relation to psychological learning theory and experimental findings. Prerequisite: Psy. 431 or 414. *Mr. Smith*
539. MOTIVATION AND EMOTION (3) Systematic status of instinct, drive, motive, will, purpose; methodology and results of physiological, experimental, and clinical investigation of basic drives. Prerequisite: Psy. 503. *Mr. Hall*
540. SEMINAR IN CLINICAL PROBLEMS (1-6) Contemporary psychological theory, research, and methodology in relation to clinical psychology. Prerequisites: Psy. 542, 560.

541. PERSONALITY THEORY (3-4) Contemporary theories of personality and relevant research with emphasis upon normal processes. Prerequisite: Psy. 438.  
*Mr. Gorlow*
542. PSYCHOPATHOLOGY (3-4) Theories of pathological behavior with reference to clinical and experimental data. Prerequisites: Psy. 412, 541. *Mr. Urban*
543. SURVEY OF COUNSELING AND PSYCHOTHERAPY (3) Critical analysis of important systems of psychotherapy; history, rationale, and method. Prerequisite: Psy. 541. *Mr. Ford*
551. THEORY AND PRACTICUM IN CLINICAL APPRAISAL OF ABILITIES AND INTELLIGENCE I (3-4) Theories of intellectual behavior; introduction to clinical testing with emphasis on individual intelligence tests. Prerequisites: Psy. 450, 482; or 15 credits in psychology. *Miss Piers*
552. THEORY AND PRACTICUM IN CLINICAL APPRAISAL OF ABILITIES AND INTELLIGENCE II (3) Theory, development of tests, and research in intellectual assessment; practicum experience with institutionalized subjects. Prerequisite: Psy. 551. *Miss Piers*
553. ADVANCED THEORY OF CLINICAL ASSESSMENT (3) Problems in clinical assessment of cognitive functioning, such as assessment of brain injury, aphasic behaviors, etc. Prerequisites: Psy. 552, 542.
555. THEORY AND PRACTICUM IN CLINICAL ASSESSMENT OF PERSONALITY (3) Theoretical issues and research in clinical assessment with special reference to administration and interpretation of projective methods. Prerequisites: Psy. 552, 542. *Messrs. Guthrie and Gorlow*
556. THEORY AND PRACTICUM IN CLINICAL ASSESSMENT OF PATHOLOGICAL SYNDROMES (3) Current research and theoretical issues in the clinical assessment of pathological syndromes; includes practicum. Prerequisite: Psy. 555. *Messrs. Guthrie and Gorlow*
557. ADVANCED PERSONALITY ASSESSMENT (3) Personality and measurement theories related to problems of prediction, diagnosis, and research. Prerequisite: Psy. 556. *Messrs. Guthrie and Gorlow*
560. PRACTICUM IN CLINICAL METHODS (3-6) Personality and vocational diagnostic evaluations and short-term counseling with adults and children. Prerequisites: Psy. 482, 541, 551.
561. CLINICAL PRACTICUM WITH CHILDREN (1-3) Diagnosis and counseling of child-parent problems of learning and adjustment; includes principles of school psychology. Prerequisite: Psy. 560. *Miss Piers*
564. THEORY AND PRACTICUM IN COUNSELING AND PSYCHOTHERAPY WITH ADULTS (3-6) Counseling with personal adjustment problems referred to the Psychology Clinic. Prerequisites: Psy. 543, 560. *Mr. Snyder*
567. THEORY AND PRACTICUM IN COUNSELING AND PSYCHOTHERAPY WITH CHILDREN (1-3) Practical experience in the Psychology Clinic in use of play therapy with young children; staff meetings; seminar on principles and techniques. Prerequisites: Psy. 543, 560, 564. *Miss Piers*



## PSYCHOLOGY

569. ADVANCED THEORY AND PRACTICUM IN COUNSELING AND PSYCHOTHERAPY (3-6) Practical experience in the Psychology Clinic in advanced nondirective therapy techniques; staff meetings; case conferences. Prerequisite: Psy. 564.

Mr. Snyder

570. INTERNSHIP IN PROFESSIONAL PSYCHOLOGY (1-9) Internship, under supervision of graduate faculty, in institution with practicing psychologists, where student is not regularly employed. Prerequisite: 3 semesters of graduate work in psychology.

Unit A. *Comparative Psychology*

Unit B. *Educational and Developmental Psychology*

Unit C. *General Experimental Psychology*

Unit D. *Industrial and Business Psychology*

Unit E. *Social Psychology*

Unit F. *State Institutional Psychology*

571. SOCIAL PSYCHOLOGY (3) Historical development of theory and methods; determinants and principles of complex social or interactional behavior; contemporary problems and research. Prerequisites: 3 credits in social psychology.

Mr. Siegel

580. THEORY AND CONSTRUCTION OF ATTITUDE SCALES (3) Measurement of social, political, commercial, and industrial attitudes; questionnaire designs. Prerequisite: 3 credits in statistics.

582. (P.H. 582, Zool. 582). RESEARCH IN ANIMAL BEHAVIOR (2-6 per semester) Research in special areas of animal behavior involving field or laboratory work. Prerequisite: Psy. (P.H., Zool.) 401; or Psy 403.

Messrs. Hale and Schein

590. PROBLEMS IN CLINICAL RESEARCH (1-6) Prerequisite: Psy. 415.

591. SEMINAR ON TEACHING PSYCHOLOGY (1-3) Objectives and content of psychology; organization and presentation of material; teaching aids and techniques.

Mr. Whaley

## RECREATION EDUCATION

FRED M. COOMBS, *in Charge of Recreation Education*  
244 Recreation Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

Students may prepare for recreation administrative positions in public recreation systems, industries, hospitals, camps, or private agencies; or for leadership of special groups in a particular activity. The areas for specialization include: (1) history, philosophy, and principles; (2) administration and supervision; (3) planning areas and facilities; (4) program content and application; (5) surveys and appraisals; (6) principles of the group process; and (7) research.

## RECREATION EDUCATION

For admission an undergraduate major in recreation education is desirable; but a major in sociology, music, physical education, fine or industrial arts, theatre arts, or other related fields may be accepted.

Students who lack some of the prerequisite courses may be admitted but are required to make up the deficiency without degree credit.

### RECREATION EDUCATION (RC ED)

- 430. CAMPING AND OUTDOOR EDUCATION (3)
- 434. (L.Arch. 434). RECREATION AREAS AND FACILITIES (3)
- 456. SOCIAL RECREATION (3)
- 461. COMMUNITY RECREATION (3)
- 465. ADMINISTRATION OF RECREATION (3)
  
- 530. CAMP ADMINISTRATION (3) Camp site development; staff selection, training, and supervision; development of objectives and program planning; values inherent in outdoor and camping education. Prerequisite: Rc.Ed. 430.
- 533. RECREATION STUDIES, SURVEYS, AND APPRAISALS (3) Types, purposes, and methods of conducting recreation studies and surveys; procedures in appraisal of community recreation. Prerequisite: Ph.Ed. 530.
- 560. ADMINISTRATIVE PROBLEMS OF RECREATION (3) Administrative problems in park and recreation departments; departmental organization, finance, personnel, facilities, program, and public relations. Prerequisite: Rc.Ed. 465.

## ROMANCE LANGUAGES AND LITERATURES

FRANKLIN B. KRAUSS

*Head of the Department of Romance Languages*

301 Sparks Building

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Professors Eyer, Hyslop, Krauss, and LeSage; Associate Professors Belasco, Brentin, and Chapman; Assistant Professors Bleznick, Moser, and Sturcken.

The minimum requirement for admission to an advanced degree program will normally be 24 credits of post-intermediate work in language and literature. A student concentrating in either French or Spanish may, if he wishes, choose the second area as a minor.

### FRENCH (FR)

- 400. FRENCH LITERATURE OF THE RENAISSANCE (3)
- 405. FRENCH LITERATURE IN THE ROMANTIC PERIOD (3)
- 406. FRENCH LITERATURE IN THE REALISTIC PERIOD (3)
- 411. FRENCH PROSE OF THE 20TH CENTURY (3)
- 413. CONTEMPORARY FRENCH DRAMA (3)
- 416. FRENCH POETRY AND DRAMA OF THE 20TH CENTURY (3)

## ROMANCE LANGUAGES

421. THE TEACHING OF ROMANCE LANGUAGES (3)  
431. FRENCH LITERATURE OF THE CLASSICAL PERIOD (3)  
433. THE AGE OF ENLIGHTENMENT (3)  
437. THE FRENCH ANALYTICAL NOVEL (3)  
471. PROBLEMS IN FRENCH LITERATURE (3-6)  
490. ADVANCED COMPOSITION AND CONVERSATION (3)
- \*1G. ELEMENTARY FRENCH FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.
501. FRENCH DRAMA OF THE CLASSICAL PERIOD (3) Origins and developments of French classical comedy and tragedy, emphasizing the works of Corneille, Racine, and Molière.
549. SYMBOLISM (3) The anti-positivistic tradition in 19th century French literature dealing with the Symbolist School, its antecedents and its subsequent ramifications.
552. MEDIEVAL FRENCH LITERATURE (3) Familiarizes the student with Old and Middle French texts from the earliest monuments to Villon. Prerequisite: R.Ph. 551.
553. FRENCH LITERATURE OF THE RENAISSANCE (3) The French Renaissance from 1498 to 1548.
562. FRENCH THINKERS OF THE 18TH CENTURY (3)
564. FRENCH ROMANTICISM (3) The French Romantic movement after 1830.
570. VOLTAIRE AND ROUSSEAU (3)
571. SEMINAR IN FRENCH LITERATURE (3-12) Lectures on methods of research. Students will pursue common and individual investigations in fields selected after consultation with the instructor.
572. SEMINAR IN FRENCH LITERATURE (3) Continuation of Fr. 571.
580. PROUST AND GIDE (3)

## ITALIAN (IT)

571. SEMINAR IN ITALIAN LITERATURE (3) Lectures on methods of research. Students will pursue common and individual investigations in fields selected after consultation with the instructor.

## PORTUGUESE (PORT)

571. SEMINAR IN PORTUGUESE LITERATURE (3-6) Prerequisite: Port. 4.

## SPANISH (SPAN)

401. THE GOLDEN AGE (3)  
402. DRAMA OF THE GOLDEN AGE (3)  
403. DON QUIXOTE (3)  
404. OLD SPANISH LANGUAGE AND LITERATURE (3)

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\*No graduate credit is given for this course.



## ROMANCE LANGUAGES

- 405. SPANISH DRAMA OF THE 19TH CENTURY (3)
- 407. THE SPANISH NOVEL OF THE 19TH CENTURY (3)
- 408. THE CONTEMPORARY SPANISH NOVEL (3)
- 409. INTRODUCTION TO LATIN-AMERICAN LITERATURE (3)
- 410. INTRODUCTION TO LATIN-AMERICAN LITERATURE (3)
- 411. MEXICO: ITS LANGUAGE AND LITERATURE (3)
- 417. SPANISH LITERATURE IN THE ROMANTIC PERIOD (3)
- 421. THE TEACHING OF ROMANCE LANGUAGES (3)
- 471. PROBLEMS IN SPANISH LITERATURE (3-6)
- 490. ADVANCED COMPOSITION AND CONVERSATION (3)
  
- \*1G. ELEMENTARY SPANISH FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.
  
- 501. GOLDEN AGE LITERATURE (3) Nature and development of Spanish literature of the 16th and 17th centuries.
  
- 538. THE GENERATION OF 1898 (3) Principal works and intellectual trends of the period with special emphasis on Unamuno.
  
- 549. MODERNISMO (3) The movement, its antecedents, and its followers, with special emphasis on Rubén Darío.
  
- 552. MEDIEVAL SPANISH LITERATURE (3) Familiarizes the student with Old Spanish texts.
  
- 561-562. SPANISH DRAMA PREVIOUS TO LOPE DE VEGA (3 each) Origin and early development of the Spanish national drama. Representative plays of different types will be read and discussed.
  
- 565. LOPE DE VEGA (3)
- 566. LOPE DE VEGA'S FOLLOWERS (3)
- 567-568. CERVANTES AND HIS WORKS (3 each)
  
- 571. SEMINAR IN PORTUGUESE LITERATURE (3-6) Prerequisite: Port. 4.  
Students will pursue common and individual investigations in fields selected after consultation with the instructor.
  
- 572. SEMINAR IN SPANISH LITERATURE (3) Continuation of Span. 571.

### ROMANCE LITERATURE (R LIT)

- 544. NEOCLASSICISM IN THE ROMANCE LITERATURES (3) The neoclassical movement in the Romance literatures, with emphasis on French and Spanish.
  
- 545. ROMANTICISM IN THE ROMANCE LITERATURES (3) The Romantic movement in the Romance literatures, with emphasis on French and Spanish.
  
- 546. MEDIEVAL ROMANCE LITERATURES (3) Medieval writings in the Romance literatures, with emphasis on French and Spanish.
  
- 547. REALISM IN THE ROMANCE LITERATURES (3) The Realistic movement in the Romance literatures, with emphasis on French and Spanish.

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\*No graduate credit is given for this course.

## ROMANCE LANGUAGES

554. THE RENAISSANCE IN THE ROMANCE LITERATURES (3) The effect of the Renaissance on the Romance literatures, with emphasis on French and Spanish.

### ROMANCE PHILOLOGY (R PH)

551. ROMANCE PHILOLOGY (3)
558. ADVANCED LINGUISTICS AND PHONETICS OF THE ROMANCE LANGUAGES (3)
573. THEORY AND TECHNIQUES OF TEACHING THE ROMANCE LANGUAGES (1-2)
574. METHODS AND BIBLIOGRAPHY IN ROMANCE LANGUAGES AND LITERATURES (1-2)

## RURAL SOCIOLOGY

MACKLIN E. JOHN

*Head of the Department of Agricultural Economics and Rural Sociology*  
1 Weaver Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Bonser, Brandow, and John; Associate Professors Buck and Nolan; Assistant Professors Bylund, Copp, Fliegel, and Freeman.

The entering student in the master's program should have as prerequisites 3 credits in rural sociology, 3 credits in sociology, and 3 additional credits in either field. If he does not have these prerequisites, he may take them at this University during the early part of his master's program.

### RURAL SOCIOLOGY (R SOC)

402. CONSUMER BEHAVIOR AND THE AGRICULTURAL INDUSTRY (3) *Mr. Bylund*
452. RURAL ORGANIZATION (3) *Mr. Copp*
459. RURAL SOCIAL PSYCHOLOGY (3) *Mrs. Nolan*
551. RURAL SOCIOLOGY SEMINAR (1-6) Prerequisite: 6 credits in rural sociology, sociology, or psychology.
552. ADVANCED RURAL SOCIOLOGY (3) Structure and functioning of rural society. *Mr. Copp*
553. SEMINAR IN RURAL SOCIOLOGICAL RESEARCH (1-6) Continuation of R.Soc. 552. Functioning of rural society; research dealing with the subject reviewed and evaluated.
554. ADVANCED RURAL SOCIAL WELFARE (3) Analysis of welfare techniques and their application to rural situations. Prerequisites: R.Soc. 11; Psy. 2 or R.Soc. 459.

555. THE RURAL CHURCH (3) The rural church as a social institution; its relation to the community; the church in "problem" areas; effects of population trends on the program of the rural church; use of case studies and surveys. Prerequisite: 6 credits in rural sociology, sociology, or psychology.
557. THE DEVELOPMENT OF THE RURAL COMMUNITY (3) Origin and evolution of the rural community under different geographic and cultural conditions. Prerequisites: R.Soc. 11 or Soc. 1; R.Soc. 452.
559. ADVANCED RURAL SOCIAL PSYCHOLOGY (3) Application of social psychological principles to treatment of rural problems. Prerequisites: R.Soc. 11, Psy. 2.  
Mrs. Nolan

## SANITARY ENGINEERING

(See page 82, Civil Engineering)

## SECONDARY EDUCATION

JAMES H. MOYER, *Head of the Department*  
207A Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Gemmell, McGarey, Moyer, Patrick, Remaley, and Veon; Associate Professors Fowler, Kozak, and Torkelson; Assistant Professors Page and Weiss.

Graduate degree programs in the department are provided primarily for the advanced preparation of competent public school teachers.

In general, candidates for the M.Ed. in secondary education must have 18 approved undergraduate credits in education and psychology including practice teaching in an area appropriate to the major, and aptitude for and interest in advanced professional preparation. Applicants are encouraged to have had at least two years of successful teaching experience.

While candidates are required to specialize in secondary education, they are encouraged to acquire a general education in the social sciences, the behavioral sciences, and the humanistic foundations.

The M.Ed. degree may be earned, in general, in those fields outside of secondary education for which a master's degree has been approved, provided such a professional program is appropriate. Thus, for example, the M.Ed. degree may be earned with a major in English or chemistry. These programs require an approved minor in educational foundations.

### SECONDARY EDUCATION (SEC ED)

400. THE SCIENTIFIC DIRECTION OF LEARNING ACTIVITIES (2-4)  
426. TEACHING MATHEMATICS IN THE SECONDARY SCHOOL (3)



## SECONDARY EDUCATION

- 433. TEACHING SOCIAL STUDIES IN THE HIGH SCHOOL (2-3)
- 436. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE SECONDARY SCHOOL (3)
- 437. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE SECONDARY SCHOOL (3)
- 438. TEACHING SCIENCE IN SECONDARY SCHOOLS (2-3)
- 443. READING PROBLEMS IN THE SECONDARY SCHOOL (2-3)
- 453. TEACHING SECONDARY SCHOOL ENGLISH (2-3)
- 454. EXTRACURRICULAR ACTIVITIES IN THE JUNIOR AND SENIOR HIGH SCHOOL (2-3)
- 456. PRINCIPLES AND PROBLEMS IN BUSINESS EDUCATION (1-3)
- 459. IMPROVEMENT OF INSTRUCTION IN BUSINESS SKILL SUBJECTS (1-3)
- 460. CURRICULUMS IN BUSINESS EDUCATION (3)
- 461. IMPROVEMENT OF INSTRUCTION IN BASIC BUSINESS SUBJECTS (3)
- 462. TEACHING OF SHORTHAND AND TYPEWRITING (3)
- 463. TEACHING OF BOOKKEEPING (3)
- 464. METHODS OF TEACHING DISTRIBUTIVE EDUCATION (3)
- 466. TEACHING OF OFFICE PRACTICE (3)
- 467. TEACHING OF SHORTHAND (2-3)
- 468. TEACHING OF TYPEWRITING (2-3)
- 472. MEASUREMENT OF ACHIEVEMENT IN THE SECONDARY SCHOOL (2-3)
- 497. WORKSHOP IN SELECTED STUDIES IN SECONDARY EDUCATION (1-6)
  
- 510. INTERNSHIP IN SECONDARY SCHOOL TEACHING (3-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
  
- 511. INTERNSHIP IN BUSINESS EDUCATION SUPERVISION (3-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
  
- 525. MODERN TENDENCIES IN EDUCATIONAL METHOD (2-3) Study of science supporting dynamic instruction; principles of teaching as guides; analysis of modern procedures; understanding of learning; substance versus plans. Prerequisite: 12 credits of undergraduate work in education.
  
- 532. SUPERVISION OF STUDENT TEACHERS (3) A course in supervision for master teachers, department heads, and college teachers with supervisory responsibilities in teacher education. Prerequisite: teaching experience and 18 credits in education, including at least 5 in methods.
  
- 537. (Bot. 537, Zool. 537). WORKSHOP IN THE BIOLOGICAL SCIENCES (3) Projects designed for teachers of biology in the secondary schools.
  
- 550. PROBLEMS IN MODERN SECONDARY EDUCATION (1-4) Historical, psychological, social, and economic factors influencing secondary education; required as basic course of all graduate students in secondary education. Prerequisite: secondary school teaching.

## SECONDARY EDUCATION

551. SEMINAR IN CONTEMPORARY ISSUES IN THE SECONDARY SCHOOL CURRICULUM (2-3) Principles and philosophy of curriculum construction. Each student works out an individual problem in the secondary school curriculum. Prerequisites: 12 credits in education and psychology, and teaching experience.
552. SEMINAR IN CONTEMPORARY ISSUES IN LABORATORY STUDIES IN THE APPLICATION OF EDUCATIONAL METHOD (2-3) Analysis and application of outstanding studies in secondary education; integration of results of educational research with public school procedures. Prerequisites: 12 credits in education and psychology, and teaching experience.
553. SEMINAR IN CONTEMPORARY ISSUES IN THE ORGANIZATION AND ADMINISTRATION OF SECONDARY EDUCATION (2-3) Problems in the reorganization of secondary education, with particular reference to philosophy, organization, and teaching problems of the junior high school. Prerequisites: 12 credits in education and psychology, and teaching experience.
575. ADMINISTRATION AND SUPERVISION IN BUSINESS EDUCATION (3) Work of administrators, supervisors, and others responsible for improvement of instruction in business education; use of vocational testing; job analysis. Prerequisite: 6 credits in secondary education.
576. INTRODUCTION TO RESEARCH IN BUSINESS EDUCATION (3) Methods of research in business education; opportunity to compile annotated bibliographies on current problems; analysis and evaluation of significant research.
577. EVALUATION OF RESEARCH AND EMPIRICAL LITERATURE IN BUSINESS EDUCATION (3) Application of evaluation methods to current literature in business education; special attention to research studies. Prerequisite: Ed. 576.
578. SEMINAR IN BUSINESS EDUCATION (1-6) Intended for graduate students preparing theses or final documents, or for those working on special studies in business education. Prerequisite: Ed. 577.
585. CURRICULUM CONSTRUCTION (2-3) Functions of administrators, supervisors, teachers, pupils, and laymen in curriculum building to meet pupil and community needs.
594. SEMINAR IN SECONDARY EDUCATION (1-3) Conferences and discussions designed to meet the need for special study of particular fields in secondary education. Prerequisite: 12 credits of graduate work in education.
597. WORKSHOP IN CURRENT EDUCATIONAL PROBLEMS IN SECONDARY EDUCATION (1-6) For administrators, supervisors, experienced secondary teachers, guidance workers; administrative, supervisory, and instructional problems involved in an emerging educational program. Prerequisite: 12 credits of graduate work in education.
598. PROBLEMS, PROJECTS, AND AREA STUDIES IN SECONDARY EDUCATION (1-6) Independent work in the study of topics in secondary education or the development of new curriculums, materials, or procedures for teaching. Prerequisites: 12 credits of graduate work in education and approval of the department head.

## SOCIAL STUDIES

### SOCIAL STUDIES

NEIL A. McNALL  
*Chairman of the Committee on Social Studies*  
115 Sparks Building

*Degree Conferred:* M.Ed.

This program, which is designed to meet the needs of secondary school teachers, consists of at least 24 credits chosen from economics, history, human geography, political science, and sociology, and a minor of at least 6 credits in educational foundations. A candidate is expected to complete at least 3 credits in each of four fields and not more than 12 credits in one of them.

To undertake graduate work in this field, the student must have had solid preparation in the basic courses in history, political science, economics, and sociology; and he should have had some advanced undergraduate work in at least one of the fields named. He should be certified for teaching social studies, and ideally he should have had teaching experience in this field as well.

### SOCIOLOGY

WILLIAM G. MATHER  
*Head of the Department of Sociology and Anthropology*  
123 Sparks Building

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Professors Bernard, Clark, Coutu, Mather, F. R. Matson, and Mook; Associate Professor Dupree; Assistant Professors Baker, Dansereau, M. B. Matson, and Theodorson.

Undergraduate preparation must include 12 credits in sociology and at least 7 in other social sciences, with a broad background in the arts and sciences preferred. Students of exceptional ability who are slightly deficient in undergraduate preparation may be accepted, on condition that they make up their deficiency in courses without degree credit.

Anthropology may be chosen as a minor field of study by students who are majoring in sociology as well as in other areas.

#### SOCIOLOGY (SOC)

- 400. SOCIOLOGICAL PRINCIPLES (3)
- 401. SOCIAL INSTITUTIONS (3)
- 403. ADVANCED SOCIAL PSYCHOLOGY (3) Mr. Coutu
- 405. SOCIAL ADJUSTMENT IN WORK LIFE (3)
- 408. SOCIAL ECOLOGY (3)
- 413. METHODS AND TECHNIQUES OF SOCIAL RESEARCH (1-6) Mr. Dansereau
- 418. THE DEVELOPMENT OF SOCIAL THOUGHT (3)
- 424. SOCIAL CHANGE (3)



## SOCIOLOGY

- 425. CONTEMPORARY SOCIOLOGICAL THEORY (3)
- 426. INTRODUCTION TO PUBLIC WELFARE (3)
- 427. SOCIAL CASE WORK (3)
- 429. SOCIAL STRATIFICATION (3)
- 431. COMMUNICATION AND MASS SOCIETY (3)
- 450. COMMUNITY ORGANIZATION (3)
- 455. OCCUPATIONS AND PROFESSIONS (3)
- 470. USE OF STATISTICS IN SOCIOLOGY (3) *Mr. Clark*
- 499. FOREIGN STUDY IN SOCIOLOGY (2-6)
  
- 500. SEMINAR IN GROUP THEORY (1-3) The group as a unit of social structure and action.
- 503. RESEARCH SEMINAR IN SOCIAL PSYCHOLOGY (3-6) Design and conduct of research in areas of mutual interest in social psychology. *Mr. Coutu*
- 505. CURRENT SOCIAL THEORY (3) Current contributions to social theory; their relations to each other and to the larger theoretical structure. *Mr. Theodorson*
  
- 510. FIELD WORK IN SOCIOLOGY (1-6)
- 513. SEMINAR IN SOCIOLOGICAL RESEARCH PROBLEMS: A. RESEARCH TECHNIQUES; B. CURRENT RESEARCH (3-6) Prerequisite: 3 credits in statistics. *Mr. John*
- 515. SEMINAR IN COMMUNITY STUDIES (3) *Mrs. Bernard*
- 516. SEMINAR IN SOCIOLOGICAL THEORY (3-6)
- 523. POPULATION PROBLEMS (1-6)
- 525. SEMINAR IN SOCIOLOGY (1-6) Research problems in theoretical and applied sociology.
- 530. RESEARCH ON MARRIAGE AND THE FAMILY (3) Training in methods and techniques of research in family relations. Experimental, statistical, and comparative studies are carried out, individually or co-operatively. Prerequisite: 3 credits of previous work in this field. *Mrs. Bernard*
- 555. INDUSTRIAL SOCIOLOGY (3) Research methods and techniques in industrial sociology; current research, unexplored areas.
- 572. METHODS OF SAMPLING (3) Application of sampling techniques to sociological research. *Mr. Clark*

## ANTHROPOLOGY (ANTHY)

- 401. PHYSICAL ANTHROPOLOGY: HUMAN EVOLUTION (3) *Mr. Baker*
- 402. HUMAN ECOLOGY (3) *Mr. Baker*
- 442. ANTHROPOLOGY OF THE NEW WORLD (3)
- 443. ANTHROPOLOGY OF THE OLD WORLD AND MIDDLE EAST (3) *Mr. Mook*
- 445. PRIMITIVE SOCIETY (3) *Mr. Mook*

## SOCIOLOGY

540. ANTHROPOLOGICAL THEORY (3) Theory used in culture-historical, sociological, and psychological interpretations. *Mr. Mook*
541. RESEARCH METHODS IN ANTHROPOLOGY (3) Principles, techniques, and examples of both field and library research in anthropology. Students will prepare research plans for class discussion.
545. SEMINAR IN ANTHROPOLOGY (1-9) Critical analysis of research in selected areas of regional ethnography and ethnological theory. Prerequisites: Anthy. 45, 445. *Mr. Mook*

## ARCHAEOLOGY (ARCHY)

- 400-401. ARCHAEOLOGY OF THE NEAR EAST (3 each) *Mr. Matson*
- 402-403. ARCHAEOLOGY OF THE NEW WORLD (3 each) *Mr. Matson*

## SPEECH

ROBERT T. OLIVER, *Head of the Department*  
300 Sparks Building

*Degrees Conferred:* Ph.D., D.Ed., M.A., M.Ed.

*Graduate Faculty:* Professors McDonald, Oliver, Schug, and Zelko; Associate Professors Brubaker, Carter, Fife, Frick, Holtzman, Nelson, and Siegenthaler; Assistant Professor DeBoer.

The student may specialize in speech arts (interpretation, drama, theatre); radio and television; rhetoric and public address (including discussion, communication, teaching of speech); speech science (voice, diction, phonetics, general semantics); or speech pathology and audiology.

The minimum undergraduate preparation required is 12 credits in speech, including a beginning public speaking course and speech science with group discussion and persuasion. Students who cannot meet this requirement in full may be admitted, but must make up their deficiencies without credit toward the graduate degree. If a specific course in speech research methods is not offered, Spch. 401 will be required as a part of the graduate program.

## SPEECH (SPCH)

400. TEACHING OF SPEECH (3) *Mr. Schug*
401. PROBLEMS, METHODS, AND AREAS IN SPEECH (3) *Mr. Carter*
402. INTRODUCTION TO GENERAL SEMANTICS (3) *Mr. Carter*
410. ENGLISH PHONETICS AND PRONUNCIATION (3) *Mr. Brubaker*
412. SPEECH COMPOSITION (3) *Mr. DeBoer*
415. EXPERIMENTAL AND APPLIED PHONETICS (3) *Mr. Brubaker*
425. ADVANCED PRINCIPLES OF RADIO SPEECH (3) *Mr. Nelson*
431. ANATOMY AND PHYSIOLOGY OF THE EAR AND VOCAL MECHANISMS (3) *Mr. Brubaker*
435. TELEVISION AND RADIO ORGANIZATION (3) *Mr. Nelson*
437. ADVANCED PRINCIPLES OF TELEVISION SPEECH (3) *Mr. Nelson*
445. CONTEMPORARY PUBLIC ADDRESS (3)
450. DISCUSSION TECHNIQUES (3)

500. SEMINAR IN AMERICAN ORATORY (2-4) History of American oratory, with application of critical standards to the work of specific orators. Prerequisite: 6 credits in speech, including Spch. 200. *Mr. Oliver*
505. HISTORICAL DEVELOPMENT OF SPEECH THEORY (2-4) Survey of ancient, medieval, and modern theories of public address in relation to currently accepted speech theories. *Mr. DeBoer*
508. SEMINAR IN BRITISH ORATORY (2-4) History of British oratory; application of critical standards to the work of selected orators. *Miss Fife*
510. SEMINAR IN SPEECH PEDAGOGY (2-4) *Mr. Carter*
520. SEMINAR IN SPEECH SCIENCE (2-4) Seminar in physical and physiological bases of speech and voice; introduction to laboratory techniques used in speech research. Prerequisite: 9 credits in speech, speech education, or psychology. *Mr. Brubaker*
540. SEMINAR IN PROBLEMS OF TELEVISION AND RADIO (2-4) Study and research in television and radio as they pertain to programming, production, relation to society, and speech. *Mr. Nelson*
550. SEMINAR IN ORAL PERSUASION (2-4) Theory and devices of persuasion; analysis of persuasive discourse. Prerequisite: 6 credits in speech including Spch. 200. *Mr. Holtzman*
552. ORAL COMMUNICATION IN INDUSTRY, BUSINESS, AND GOVERNMENT (2-4) Needs, practices, and methods in American industry, business, and government; methods of training adults in oral communication skills. *Mr. Zelko*
555. SPEECH COMMUNICATION: PROBLEMS AND PRINCIPLES (2-4) Prevalent theories of speech influence. *Mr. Oliver*
560. PUBLIC ADDRESS (2-4) Discussion and criticism of speech outline, manuscript, content, composition, and delivery. Prerequisite: 6 credits in speech including Spch. 200. *Mr. Schug*
575. RESEARCH PROBLEMS IN SPEECH (1-12) Advanced research on an individual basis in oratorical criticism, discussion techniques, persuasion, pedagogy, phonetics, speech science, and speech pathology. Prerequisite: 12 credits in speech or in speech education.

## STATISTICS

JAMES B. BARTOO, *Chairman of the Committee on Statistics*  
219 Sparks Building

No advanced degree is offered in this field but a candidate with a major in another field may choose a minor in statistics upon approval by his major department.

This minor is intended to facilitate development of a coherent program of study in this vital branch of the scientific method. The candidate will be expected to become conversant with the broad field of statistics and to become reasonably proficient in the statistical methods particularly useful in the subject-matter areas



## STATISTICS

of his major field. The member of the candidate's committee representing the minor in statistics will have responsibility for determining course work acceptable in satisfying requirements for the minor.

The minimum requirements for a minor for a master's degree are 3 credits in mathematical statistics and 6 in applied statistics. For a doctor's degree a minimum of 15 credits in statistics is required for a minor, of which at least 6 must be mathematical statistics and at least 6 must be applied statistics.

Courses in mathematical statistics are: Math. 409, 410, 542, and 543.

Courses in applied statistics are: Ag. 400; A.B.Ch. 515; Ag.Ec. 505; Ag.Ed. 521v; Agro. 512, 545; B.S. 500, 501; Econ. 480; Ed.Ser. 490, 590; For. 450; I.E. 423; Meteo. 450; Min. 513, 514, 526; Psy. 415, 515, 527; and Soc. 470, 572.

## THEATRE ARTS

WALTER H. WALTERS, *Head of the Department*  
201 Schwab Auditorium

*Degree Conferred:* M.A.

*Graduate Faculty:* Professor Neusbaum; Associate Professors Reifsneider, Smith, Walters, and Yeaton.

Under certain circumstances the Ph.D. degree is offered by the Department of English with specialization in drama and minor work in theatre arts.

A course in basic acting, one in directing, and one in theatre crafts, or their equivalents, are required for admission. In addition, the student must have had 12 credits divided between speech and the arts (including music, sculpture, painting, architecture, and other courses in which art is practiced); or a minimum of 9 credits in one of these; or a minimum of 9 credits in English and literature, including at least 6 in dramatic literature, or 3 in dramatic literature and 3 in advanced creative writing.

### THEATRE ARTS (THEA)

- 403. ADVANCED MAKE-UP (1)
- 404. STYLES OF ACTING (3-6)
- 412. ADVANCED SCENE DESIGN (3)
- 413. STAGE LIGHTING (3)
- 415. THEATRE ORGANIZATION AND MANAGEMENT (3)
- 421. ADVANCED PLAYWRITING (3)
- 431. HISTORY OF THE THEATRE (3)
- 442. CREATIVE DRAMATICS WITH CHILDREN (3)
- 443. MARIONETTES AND PUPPETRY (3)
- 451. DIRECTING (3)
- 452. CENTRAL STAGING (3)
- 470. THEATRE PRODUCTION (3-6)
- 480. RADIO DRAMA (3)
- 481. TELEVISION DRAMA (3)

501. PROBLEMS OF DIRECTING (3-6) Seminar in problems of production with particular stress on direction. Students will direct plays under staff supervision.
502. SEMINAR IN THE TECHNICAL PROBLEMS OF DRAMATIC PRODUCTION (3-6)  
Prerequisite: Thea. 11.
504. SEMINAR IN STYLES OF ACTING (3-6) Practical work required of each student.
506. EVALUATION AND APPRECIATION OF MODERN DRAMATIC ENTERTAINMENT (3) Prerequisites: Thea. 1, 61.
507. SEMINAR IN FUNDAMENTAL THEORIES OF THEATRE AND DRAMA (3-6)
521. PLAYWRITING (3-6) Prerequisites: Thea. 21, 421.

## VOCATIONAL INDUSTRIAL EDUCATION

(See page 125, Industrial Arts Education)

## WILDLIFE MANAGEMENT

*Consult* BERTIL G. ANDERSON  
212 Frear Laboratory

The M.S. degree is offered in the field of wildlife management. Candidates select courses for this major from a number of related fields.

## ZOOLOGY

BERTIL G. ANDERSON  
*Head of the Department of Zoology and Entomology*  
212 Frear Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Anderson, Davis, and Frings; Associate Professors Anthony, Cooper, and Wood; Assistant Professors Bellis, Boyle, and Smyth.

Students may specialize in animal behavior, bioacoustics, ecology, endocrinology, fishery biology, genetics, histology, ichthyology, invertebrate zoology, invertebrate physiology, or wildlife management.

In order to undertake graduate work in zoology, students are required to have had 24 credits in zoology and related biological sciences; and they should have had chemistry through organic chemistry. Courses in physics and mathematics are also advantageous. A limited deficiency can be made up without degree credit while pursuing graduate work.

### ZOOLOGY (ZOOL)

401. (P.H. 401, Psy. 401). ANIMAL BEHAVIOR (3)  
405. (Bot. 405). GENERAL CYTOLOGY (3)

*Mr. Hale*  
*Mr. Grun*

## ZOOLOGY

408. MAMMALOLOGY (4) Mr. Davis  
 410. GENERAL LIMNOLOGY (3) Mr. Cooper  
 415. THE LITERATURE OF ZOOLOGY (1) Mr. Anderson  
 416. THE METHODS OF RESEARCH IN ZOOLOGY (2) Mr. Anderson  
 417. INVERTEBRATE ZOOLOGY (3) Mr. Frings  
 419. GENERAL ANIMAL ECOLOGY (3) Mr. Bellis  
 420. GAME BIRDS (3) Mr. Wood  
 421. COMPARATIVE ANATOMY OF VERTEBRATES (4)  
 422. (Bot. 422). ADVANCED GENETICS (3) Mr. Wright  
 432. HUMAN PARASITOLOGY (3)  
 433. (Bot. 433). GENETICS, EUGENICS, AND EVOLUTION FOR TEACHERS (3)  
Messrs. Wright and Grun  
 436. PROTOZOOLOGY (3)  
 437. HISTOLOGY (4) Mr. Anthony  
 440. EMBRYOLOGY (4)  
 441. ESSENTIALS OF HUMAN PHYSIOLOGY FOR TEACHERS (3) Mr. Tietz  
 444. ZOOLOGICAL PROBLEMS (1-6)  
 448. ORNITHOLOGY (3) Mr. Wood  
 450. ICHTHYOLOGY (4) Mr. Cooper  
 461. ANIMAL PARASITOLOGY (3)  
 505. (Bot. 505). CYTOLOGY AND CYTOGENETICS (3) Chromosome mechanism of heredity; relationship between plant and animal evolution and breeding and changes in chromosomes; cytological and cytochemical techniques. Prerequisite: Zool. (Bot.) 405 or 422. Fall semester, even years. Mr. Grun  
 508. ADVANCED PARASITOLOGY (3) Advanced work on the structure, life cycle, and control of parasites.  
 509. TECHNIQUES IN WILDLIFE MANAGEMENT (3) Preparing study mounts, census making, management area mapping, methods of collecting data, and determining food habits from stomach contents. Prerequisite: Zool. 546. Spring semester.  
 512. SEMINAR (1) Review of current zoological literature. Required of graduate students majoring in zoology and entomology. Prerequisite: 12 credits in zoology or entomology.  
 514. SPECIAL TOPICS IN ZOOLOGY (3) Individual problems in any field of zoology, with or without experimental work. Prerequisite: Zool. 26.  
 524. (Bot. 524). SEMINAR IN GENETICS (1 per semester) Mr. Wright  
 528. (Bot. 528). POPULATION GENETICS (3) Factors affecting gene frequency, genotype frequency, genotype-environmental interaction, and genetic relationship in natural and artificial populations. Fall semester, odd years.  
 533. (Bot. 533). PROBLEMS IN GENETICS (2-6) Problems to suit needs of individual students; conferences and laboratory work. Prerequisite: Zool. (Bot.) 422. Messrs. Wright and Grun  
 537. (Bot. 537, Sec.Ed. 537). WORKSHOP IN THE BIOLOGICAL SCIENCES (3) Projects designed for teachers of biology in the secondary schools. Summer sessions.



541. COMPARATIVE PHYSIOLOGY (3) Dynamics of vital processes as shown in members of the animal kingdom. Prerequisites: Zool. 26; A.B.Ch. 1; A.B.Ch. 425 or Zool. 437. Spring semester. *Mr. Smyth*
546. THE THEORY OF GAME MANAGEMENT (4) Fundamental principles underlying management of wild game birds and mammals; co-ordination of such management with various land uses; planning preserves and other land areas. Prerequisites: Zool. 408, 420. Fall semester. *Mr. Davis*
551. FISHERIES MANAGEMENT (3) Basic principles underlying management of inland waters for fish production. Prerequisite: Zool. 450. Spring semester, odd years. *Mr. Cooper*
581. ADVANCED INVERTEBRATE ZOOLOGY (3) Morphology, physiology, taxonomy, and life histories of invertebrate animals. Fall semester, even years. *Mr. Frings*
582. (P.H. 582, Psy. 582). RESEARCH IN ANIMAL BEHAVIOR (2-6 per semester) Research in special areas of animal behavior involving field and laboratory work. Prerequisite: Zool. (P.H., Psy.) 401; or Psy. 403. *Messrs. Hale, Schein, Davis, and Frings*
583. GENERAL ENDOCRINOLOGY (2) Anatomy and physiology of the organs of internal secretion; role of hormones in metabolism and development. Spring semester, odd years. *Mr. Anthony*
587. BIOLOGY OF SEX (2) Hereditary and embryological aspects, problems in gonadal differentiation, cyclic reproductive phenomena, actions of the hormones. Spring semester, even years. *Mr. Anthony*

## Part II

### Other Elective Graduate Courses

The following courses are in fields in which neither major nor minor work is offered at this institution. The courses, however, carry graduate credit and, with the approval of the major department, may be applied toward the requirements for a degree either as elective courses or as a part of a general studies program. The usual restrictions upon the use of 400 series courses in degree programs apply to these courses.

#### AGRICULTURE, GENERAL (AG)

400. INTRODUCTORY BIOMETRY (3)

#### ASTRONOMY (ASTRO)

470. SOLAR PHYSICS (3)

490-491. INTRODUCTION TO ASTROPHYSICS (3 each)

#### COMMERCIAL CONSUMER SERVICES (C C S)

403. LECTURE-DEMONSTRATION TECHNIQUES (3)

*Miss Allgood*

450. PROBLEMS IN HOUSEHOLD EQUIPMENT (1-6)

*Miss Allgood*

#### ENGINEERING (ENGR)

422. ORDNANCE ENGINEERING: TORPEDO ENGINEERING (3)

430. INTRODUCTION TO DIGITAL COMPUTER PROGRAMMING (1)

431. DIGITAL COMPUTER PROGRAMMING (3)

450. PATENT FUNDAMENTALS (3)

500. SPECIAL TOPICS IN ENGINEERING (1-3)

531. ADVANCED DIGITAL COMPUTER PROGRAMMING (3) Programming for commercial computers; programming techniques; numerical methods for computers; solution of problems on the Penn State Digital Computer. Prerequisites: Math. 405, Engr. 431.

#### GREEK (GREEK)

421. GREEK TRAGEDY (3)

*Mr. Will*

422. GREEK COMEDY (3)

*Mr. Will*

500. GREEK COMPOSITION (2) Translation of extended narrative passages into Attic Greek; thorough review of forms and syntax; attention to rhetorical elements of the language.

*Mr. Will*

#### HEALTH EDUCATION (HL ED)

403. FIRST AID, ATHLETIC CONDITIONING AND TRAINING (3)

406. RECENT DEVELOPMENTS IN SCHOOL HEALTH EDUCATION (3)

## HEALTH EDUCATION

407. ADVANCED PERSONAL AND PUBLIC HEALTH (3)  
411. PRINCIPLES AND METHODS OF TEACHING SAFETY EDUCATION (3)  
427. HEALTH FACTORS IN THE DEVELOPMENT OF THE ADOLESCENT (3)  
453. ORGANIZATION AND ADMINISTRATION OF HEALTH EDUCATION (3)  
456. ADVANCED TECHNIQUES IN RURAL SCHOOL HEALTH (3)  
501. HEALTH IMPLICATIONS IN THE GROWTH AND DEVELOPMENT OF SCHOOL CHILDREN (3) Child growth and development emphasis for teachers; medical inspection and examination; preschool program; early habit formations; behavior problems; co-operation of parents, teachers, and children. Prerequisite: Hl.Ed. 215.  
505. ADVANCED TECHNIQUES IN HEALTH EDUCATION (3) Prerequisites: Hl.Ed. 215, 399, Psy. 437.  
572. TESTS AND MEASUREMENTS IN HEALTH EDUCATION (3) Critical study, evaluation, and demonstration of tests and measures of health education; statistical computations of data. Prerequisites: Ph.Ed. 490, Hl.Ed. 215, 399.

## HOME-COMMUNITY RELATIONSHIPS (H C R)

499. INTERCULTURAL STUDIES IN HOME ECONOMICS (2-6)  
502, 502v. HOME ECONOMICS AND AMERICAN SOCIETY (3) Family life education in relation to a democratic culture; emphasis upon the interrelatedness of socioeconomic problems and the American family.  
503. GRADUATE SEMINAR IN HOME ECONOMICS (1) *Miss Henderson*

## INTERNATIONAL UNDERSTANDING (INT U)

400. WORLD AFFAIRS AND INTERNATIONAL UNDERSTANDING (3-6)

## LATIN (LATIN)

428. LUCRETIVS (3) *Mr. Krauss*  
429. QUINTILIAN (3) *Mr. Krauss*  
431. JUVENAL (3) *Mr. Krauss*  
436. FUNCTIONAL PROBLEMS IN LATIN (3)  
500. LATIN LITERATURE (3) Lectures and collateral readings on the major forms of Latin literature; readings in the original Latin to supplement the lectures. *Mr. Krauss*  
501. ROMAN RELIGION AND PHILOSOPHY (3) Development of religious concepts at Rome from primitive Italic origins to the advanced forms that culminated in Roman Stoicism. *Mr. Krauss*  
502. LATIN EPIGRAPHY (3) Lectures and readings on Roman inscriptions; illustrative exercises. *Mr. Krauss*  
503. LATIN PALEOGRAPHY (3) The Latin alphabet, writing materials, Roman book and cursive hands; illustrative exercises. *Mr. Krauss*  
504. ROMAN TOPOGRAPHY (3) Physical development of the city of Rome, its walls, aqueducts, bridges, streets, forums, public buildings, temples, etc.; building materials and methods of construction. *Mr. Krauss*  
510. LATIN SEMINAR (3) *Mr. Krauss*



## L A T I N

518. LATIN RESEARCH (1-3) Prosecution of an assigned problem under the guidance of a member of the department.

## LIBERAL ARTS (L A)

- 500-501. FUNDAMENTALS OF LINGUISTICS (3 each) Interrelated problems of language discussed from four points of view: modern structural linguistics, historical linguistics, social psychology, and philosophy.

## LIBRARY SCIENCE (L SC)

403. INTERMEDIATE DICTIONARY CATALOGING AND SUBJECT HEADINGS (3)  
405. INTERMEDIATE REFERENCE WORK AND BIBLIOGRAPHY (3)  
407. SPECIAL PROBLEMS IN SCHOOL LIBRARY SERVICE (6)

## MINERAL INDUSTRIES (MN I)

400. MINERAL INDUSTRIES IN MODERN CIVILIZATION (3)

## MINERAL SCIENCES (MN SC)

411. INSTRUMENT TECHNIQUES APPLIED TO MINERAL SCIENCE PROBLEMS (1-3)  
    *Unit A. X-Ray Diffraction*  
    *Unit B. Electron Microscopy*  
    *Unit C. Spectroscopy*  
510. X-RAY AND ELECTRON DIFFRACTION ANALYSIS AS APPLIED TO MINERALS AND METALS (2) Prerequisite: Phys. 285. *Mr. Brindley*  
520. ELECTRON MICROSCOPY IN MINERAL SCIENCE RESEARCH (1-4) Prerequisite: Mn.Sc. 411, Unit B. *Messrs. Bates and Comer*  
530. SPECTROSCOPY IN MINERAL SCIENCE RESEARCH (1-4) Prerequisite: Mn.Sc. 411, Unit C. *Mr. Lovell*  
540. SOLID STATE STRUCTURES AND REACTIONS IN MINERAL SYSTEMS (2-4)  
    Crystal chemical approach to solid state reactions, sintering, melting, hardness, thermal expansion, and behavior of matter under high pressure. *Mr. Weyl*

## NATURE EDUCATION (NA ED)

401. TRAINING IN NATURE FOR CAMP COUNSELORS (3)

## RELIGIOUS STUDIES (RL ST)

401. RELIGIOUS PHILOSOPHY OF THE GREAT REFORMERS (3)  
410. BIBLICAL STUDIES: OLD TESTAMENT (3)  
420. BIBLICAL STUDIES: NEW TESTAMENT (3)  
430. RELIGION AND MORALITY (3)

## RUSSIAN (RUS)

401. STUDIES IN RUSSIAN LITERATURE (3-6)  
426. DOSTOEVSKI (3)  
427. TOLSTOY (3)

## VETERINARY SCIENCE (V SC)

400. VETERINARY ANATOMY AND PHYSIOLOGY (3)  
401. INFECTIOUS DISEASES OF DOMESTIC ANIMALS (2)  
515. (Bact. 515). VIROLOGY (2-4) Rickettsial and viral agents parasitizing man, animals, and microorganisms. Prerequisite: Bact. 410.

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The  
Pennsylvania  
State  
University  
Bulletin

GRADUATE

DEGREE PROGRAMS

Volume II

General Catalog Issue

1962

1961



OFFICE OF THE GRADUATE SCHOOL  
104 WILLARD BUILDING

**IMPORTANT NOTICE:** Following the Spring Semester 1961, the University will operate throughout the year on a four-term basis. The fall, winter, spring, and summer terms will consist of 10 weeks each.

**LAND-GRANT CENTENNIAL:** During 1961-62 The Pennsylvania State University joins the other land-grant colleges and universities of the United States in commemorating the Centennial of the Land-Grant Act. This act, signed by President Abraham Lincoln in 1862, laid the foundation for our great system of state-supported land-grant institutions, established "to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life."

**LOCATION:** The post office address of The Pennsylvania State University is University Park, Pennsylvania, but the town in which the University is located is State College.

THE PENNSYLVANIA STATE UNIVERSITY BULLETIN  
VOLUME LV                      February 1961                      NUMBER 1

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UNIVERSITY PARK, PENNSYLVANIA

The  
Pennsylvania  
State  
University

General  
Catalog



1961-1962

Volume II

Graduate  
Degree  
Programs

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SUPPLEMENT TO  
THE PENNSYLVANIA STATE UNIVERSITY BULLETIN  
VOLUME LV                      February 1961                      NUMBER 1

Effective with the summer of 1961, The Pennsylvania State University is changing its basic calendar from two semesters plus a summer session to four terms. Each term will be of 10 weeks duration, and a full-time graduate student will be permitted to register for a maximum of 10 credits per term. Accordingly, the credit system will remain unchanged, a credit continuing to be a "semester credit" rather than the "quarter credit" associated with the traditional quarter system.

As a result of recent official action associated with the calendar change, the following items appearing in the 1961-1962 issue of *Graduate Degree Programs* have undergone the changes listed below:

\*1. GRADUATE CALENDAR (See page 4)

†SUMMER TERM 1961

JUNE 1961

- 13-14    Tuesday and Wednesday—Summer Term Registration
- 13-14    Tuesday and Wednesday—Oral Examinations in Foreign Languages  
            for Advanced Degree Candidates
- 15       Thursday—Summer Term Classes Begin 8 a.m.
- 15       Thursday—Last Date for Registering with Foreign Language Depart-  
            ments for Written Language Examinations

JULY

- 3       Monday—Written Foreign Language Examinations for Advanced De-  
            gree Candidates
- 4       Tuesday—Independence Day Recess
- 12       Wednesday—Last Date for Paying Thesis Fees and for Informing  
            Recorder of Intention To Graduate in August
- 18       Tuesday—Graduate Faculty Meeting
- 29       Saturday—Last Date for an August Graduate To Deliver Doctoral  
            Thesis to Committee

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\*This calendar was approved February 18, 1961. It is subject to change without notice.

†A *Summer Term Timetable* may be obtained by writing to the Scheduling Office, Room 4, Willard Building.

## AUGUST

- 5 Saturday—Last Date for Final Oral Doctoral Examination for August Graduates
- 5 Saturday—Last Date for an August Graduate to Deliver Master's Thesis to Adviser
- 5 Saturday—Last Date for an August Graduate to Rent Cap, Gown, and Hood Locally
- 12 Saturday—Theses Due in Graduate School Office 12 Noon
- 12 Saturday—Last Date for Submitting a Petition to Graduate in Absentia in August
- 15 Tuesday—Graduate Faculty Meeting
- 24 Thursday—Summer Term Classes End 9:55 p.m.
- 26 Saturday—Commencement

## *FALL TERM 1961*

## SEPTEMBER 1961

- 20-23 Wednesday to Saturday Noon—Fall Term Registration
- 20-23 Wednesday to Saturday Noon—Oral Examinations in Foreign Languages for Advanced Degree Candidates
- 25 Monday—Fall Term Classes Begin 8 a.m.
- 25 Monday—Last Date for Registering with Foreign Language Departments for Written Language Examinations

## OCTOBER

- 9 Monday—Written Foreign Language Examinations for Advanced Degree Candidates
- 17 Tuesday—Graduate Faculty Meeting

## NOVEMBER

- 21 Tuesday—Graduate Faculty Meeting
- 23 Thursday—Thanksgiving Day Recess

- ‡ 24 Friday—Last Date for Paying Thesis Fees and Informing Recorder of Intention To Graduate in June if Certification of Completion of Program Is To Be Issued in January
- ‡ 24 Friday—Last Date To Deliver Doctoral Theses to Committee for Candidates Seeking Certification of Completion in January
- ‡ 30 Thursday—Last Date To Deliver Master's Theses to Adviser for Candidates Seeking Certification of Completion in January
- ‡ 30 Thursday—Last Date for Final Oral Doctoral Examination for Candidates Seeking Certification of Completion in January

## DECEMBER

- ‡ 7 Thursday—Theses Due in Graduate School Office for Candidates Seeking Certification of Completion in January
- 7 Thursday—Fall Term Classes End 9:55 p.m.

## *WINTER TERM 1962*

### JANUARY 1962

- 3-4 Wednesday and Thursday—Winter Term Registration
- 5 Friday—Winter Term Classes Begin 8 a.m.

## MARCH

- 17 Saturday—Winter Term Classes End 12:25 p.m.

## *SPRING TERM 1962*

### MARCH 1962

- 26-27 Monday and Tuesday—Spring Term Registration
- 28 Wednesday—Spring Term Classes Begin 8 a.m.

## JUNE

- 8 Friday—Spring Term Classes End 9:55 p.m.
- 9 Saturday—Commencement

---

‡Degrees will not be conferred at the end of the Fall Term, but candidates for advanced degrees who meet the above deadlines will be certified by the Dean of the Graduate School as having met all requirements for their degrees—the formal conferring of the degree to be done at Commencement in June 1962.



2. LOADS, ACADEMIC AND EMPLOYMENT (See pages 27-28)

A graduate student who has no employment may take a maximum of 10 credits in a term and will be expected to take at least 8 credits. A student who is employed 10, 20, or 30 hours per week will be limited to 7-9, 5-7, and 4-5 credits respectively. A student who is employed full time may schedule a maximum of 4 credits.

3. STATUS UNDER SELECTIVE SERVICE (See page 28)

A student who schedules at least 8 credits or who holds a quarter-time or half-time graduate assistantship will be certified as a full-time student.

4. GRADUATE ASSISTANTSHIPS (See pages 31-32)

A quarter-time graduate assistant may schedule 7-9 credits, a half-time assistant 5-7 credits, and a three-quarter-time assistant 4-5 credits per term.

The scale of stipends is unchanged. Hence the stipend for a term is one third of the published stipend for the academic year.

5. COUNSELORSHIPS FOR MEN (See page 32)

A counselor may not hold a fellowship, a graduate assistantship, or a graduate grant-in-aid during the term of his appointment as a counselor; he may carry only 8 credits per term.

6. GRADUATE GRANTS-IN-AID (See page 36)

A recipient is expected to carry a full program of graduate work but may accept employment with the University or another employer not to exceed 10 hours per week, provided he reduces his academic load to 8 or 9 credits.

7. HEALTH CENTER (See page 37)

The services of the Ritenour Health Center are available to graduate students registered for 8 or more credits and to all graduate assistants, fellows, and scholars. Students are entitled to five days of free treatment each term. For each day of confinement in excess of five days a charge of \$10 will be made.

8. RESIDENCE REQUIREMENTS (See page 42)

A minimum of nine terms of full-time graduate study and research, or the equivalent in credits, is required for a doctor's degree. At least 30 credits must be earned in residence at the University Park Campus.

For a period of three terms, two of which must be consecutive, the Ph.D. candidate must limit his work load to half-time at most, the balance of his time being devoted to graduate study.

9. LANGUAGE EXAMINATIONS (See page 44)

The language examinations for advanced degree candidates will be held four times each year, once during each term.

U.Ed. 1-416

# \*GRADUATE CALENDAR

## SPRING SEMESTER 1961

### FEBRUARY 1961

- 1-4 Wednesday to Saturday Noon—Spring Semester Registration
- 1-4 Wednesday to Saturday Noon—Oral Examinations in Foreign Languages for Doctoral Candidates
- 6 Monday—Spring Semester Classes Begin 8 a.m.
- 6 Monday—Last Date for Registering with Foreign Language Departments for Written Language Examinations
- 16 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 18 Saturday—Last Date for Adding Courses to Approved Schedules

### MARCH

- 4 Saturday—Last Date for Dropping Courses from Approved Schedules
- 6 Monday—Written Foreign Language Examinations for Doctoral Candidates  
7 p.m.
- 16 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 18 Saturday—Last Date for Paying Thesis Binding Fees and for Informing Recorder of Intention to Graduate in June
- 29 Wednesday—Spring Recess Begins 11:50 a.m.

### APRIL

- 5 Wednesday—Spring Recess Ends 12:15 p.m.
- 20 Thursday—Graduate Faculty Meeting 4:10 p.m.

### MAY

- 13 Saturday—Last Date for a June Graduate to Deliver Doctoral Thesis to Committee
- 18 Thursday—Graduate Faculty Meeting 4:10 p.m.
- 20 Saturday—Last Date for Final Oral Doctoral Examination for a June Graduate
- 20 Saturday—Last Date for a June Graduate to Deliver Master's Thesis to Adviser
- 20 Saturday—Cap and Gown Fee Due 5:30 p.m.
- 27 Saturday—Spring Semester Classes End 12:15 p.m.
- 27 Saturday—Theses Due in Graduate School Office 12 Noon
- 27 Saturday—Last Date for Submitting a Petition to Graduate in Absentia in June
- 28 Sunday—Free Day to Prepare for Examinations
- 29 Monday—Spring Semester Examinations Begin

### JUNE

- 6 Tuesday—Spring Semester Ends 9:50 p.m.
- 10 Saturday—Spring Semester Commencement

\*This calendar was approved October 1, 1960. It is subject to change without notice.

## *SUMMER TERM 1961*

### **JUNE 1961**

15 Thursday—Classes Begin

### **JULY**

4 Tuesday—Independence Day Recess

### **AUGUST**

24 Thursday—Classes End

## *FALL TERM 1961*

### **OCTOBER 1961**

2 Monday—Classes Begin

### **NOVEMBER**

23 Thursday—Thanksgiving Recess

### **DECEMBER**

12 Tuesday—Classes End

## *WINTER TERM 1962*

### **JANUARY 1962**

3 Wednesday—Classes Begin

### **MARCH**

13 Tuesday—Classes End

## *SPRING TERM 1962*

### **MARCH 1962**

21 Wednesday—Classes Begin

### **APRIL**

20-22 Friday Through Sunday—Easter Recess

### **MAY**

31 Thursday—Classes End

Effective with the summer of 1961, The Pennsylvania State University will change its basic calendar from two semesters plus a 12-week summer session to four terms of 10 weeks each. Certain dates, including deadlines, had not been established for the new calendar at the time this bulletin went to press and were omitted from the calendar for the 1961-62 terms given above. However, they will appear in the more detailed calendar for these terms which will be prepared as soon as possible and will follow the general pattern shown for the Spring Semester 1961.



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BERTIL G. ANDERSON, Ph.D. (Iowa)	<i>Zoology</i>
EDWIN J. ANDERSON, M.S. (Cornell)	<i>Apiculture</i>
JOHN M. ANDERSON, Ph.D. (California)	<i>Philosophy</i>
FRANCES M. ANDREWS, D.Ed. (Penn State)	<i>Music Education</i>
JOHN G. ASTON, Ph.D. (California)	<i>Organic Chemistry</i>
ESTHER A. ATKINSON, M.S. (Kansas State)	<i>Hotel and Institution Administration</i>
ELTON ATWATER, Ph.D. (American U.)	<i>Political Science</i>
RAYMOND G. D. AYOUB, Ph.D. (Illinois)	<i>Mathematics</i>
RUTH W. AYRES, Ph.D. (Brookings)	<i>Clothing and Textiles</i>
RALPH L. BAKER, Ph.D. (Iowa State)	<i>Marketing</i>
WILLIAM L. BARR, Ph.D. (Cornell)	<i>Farm Management</i>
GEORGE P. BARRON, JR. Ph.D. (Penn State)	<i>Animal Nutrition</i>
JAMES B. BARTOO, Ph.D. (Iowa)	<i>Mathematics</i>
THOMAS F. BATES, Ph.D. (Columbia)	<i>Mineralogy</i>

# PROFESSORS

SAMUEL P. BAYARD, A.M. (Harvard)	English
CLARE A. BECKER, Ph.D. (Cornell)	Agricultural Business Management
F. JOSEPH BEDENK, A.M. (Columbia)	Physical Education
MAURICE E. BELL, Ph.D. (M.I.T.)	Geophysics
KENNETH R. BENNETT, Ph.D. (Cornell)	Agricultural Statistics
ANDREW A. BENSON, Ph.D. (California Tech.)	Agricultural and Biological Chemistry
THOMAS C. BENTON, Ph.D. (Pennsylvania)	Mathematics
JESSIE BERNARD, Ph.D. (Washington U.)	Sociology
ROBERT G. BERNREUTER, Ph.D. (Stanford)	Psychology
PAUL W. BIXBY, Ed.D. (Columbia)	Education
ALEX BLACK, Ph.D. (Rochester)	Animal Nutrition
NORRIS D. BLACKBURN, Ph.D. (Ohio State)	Entomology
HOWARD J. BONSER, Ph.D. (Penn State)	Rural Sociology Extension
ALFRED L. BORTREE, D.V.M. (Michigan State)	Veterinary Science
ROBERT V. BOUCHER, Ph.D. (Missouri)	Agricultural and Biological Chemistry
THOMAS D. BOWMAN, M.A. (Penn State)	English Literature
JOSEPH F. BRADLEY, Ph.D. (Pittsburgh)	Finance
GEORGE E. BRANDOW, Ph.D. (Cornell)	Agricultural Economics
JOHN W. BRATZLER, Ph.D. (Cornell)	Animal Nutrition
ARTHUR H. BRAYFIELD, Ph.D. (Minnesota)	Psychology
GLENN O. BRESSLER, Ph.D. (Cornell)	Poultry Husbandry
R. WALLACE BREWSTER, Ph.D. (California)	Political Science
FERDINAND G. BRICKWEDDE, Ph.D. (Johns Hopkins)	Chemistry and Physics
GEORGE W. BRINDLEY, Ph.D. (Leeds)	Solid State Technology
JOSEPH H. BRITTON, Ph.D. (Chicago)	Child Development and Family Relationships
M. VIRGINIA BRITTON, Ph.D. (Chicago)	Family Economics
CHARLES H. BROWN, M.A. (Oklahoma)	Journalism
EMORY J. BROWN, Ph.D. (Michigan State)	Rural Sociology
HUGH S. BROWN, Ph.D. (Minnesota)	Education
IRA V. BROWN, Ph.D. (Harvard)	American History
JOHN L. BROWN, Jr., Ph.D. (Brown)	Engineering Research
ROY C. BUCK, Ph.D. (Minnesota)	Rural Sociology
WILHELM R. BUESSEM, Dr.Ing. (Technical U., Berlin)	Ceramic Technology
ALBERT F. BUFFINGTON, Ph.D. (Harvard)	German
WILLIAM T. BUTZ, Ph.D. (Penn State)	Agricultural Economics
HOWARD L. CARNAHAN, Ph.D. (Minnesota)	Agronomy
CLARENCE R. CARPENTER, Ph.D. (Stanford)	Psychology
H. BEECHER CHARMBURY, Ph.D. (Penn State)	Mineral Preparation
TIEN-HSI CHENG, Ph.D. (Ohio State)	Zoology
HENRY H. CHISMAN, M.F. (Duke)	Forestry
CARL O. CLAGETT, Ph.D. (Wisconsin)	Agricultural and Biological Chemistry
ROBERT E. CLARK, Ph.D. (Chicago)	Sociology
TERESA COHEN, Ph.D. (Johns Hopkins)	Mathematics
ROSE M. COLOGNE, Ed.D. (Columbia)	Adult Education
RALPH W. CONDEE, Ph.D. (Illinois)	English Literature and Humanities
J. FRANK CONE, Ph.D. (Washington State)	Bacteriology
RAY M. CONGER, M.S. (Iowa State)	Physical Education
FRANKLIN H. COOK, M.A. (Penn State), LL.B.	Business Law
FRED M. COOMBS, Ed.D. (N.Y.U.)	Physical Education
BECKFORD F. COON, Ph.D. (Ohio State)	Economic Entomology
JOHN F. CORSO, Ph.D. (Iowa)	Psychology
WALTER COUTU, Ph.D. (Wisconsin)	Sociology
MAURICE B. CRAMER, Ph.D. (Princeton)	English



# PROFESSORS

HASKELL B. CURRY, Ph.D. (Goettingen)	Mathematics
HOWARD A. CUTLER, Ph.D. (Columbia)	Economics
JOSEPH H. DAHMUS, Ph.D. (Illinois)	Medieval History
NORMAN DAVIDS, Ph.D. (N.Y.U.)	Engineering Mechanics
ARTHUR F. DAVIS, D.P.H. (Michigan)	Physical Education
DAVID E. DAVIS, Ph.D. (Harvard)	Zoology
H. MAUZEE DAVIS, Ph.D. (Minnesota), P.E.	Chemical Metallurgy
HUGH M. DAVISON, Ed.D. (Harvard)	Educational Research
GEORGE F. DEASY, Ph.D. (Clark)	Geography
WALTER J. DELACY, D.Ed. (Buffalo)	Education
NORMAN C. DENO, Ph.D. (Ohio State)	Chemistry
HAROLD E. DICKSON, Ph.D. (Harvard)	History of Art and Architecture
CHARLES C. DIILIO, M.S. (Penn State), P.E.	Mechanical Engineering
FRANCIS J. DOAN, M.S. (Penn State)	Dairy Manufacturing
MARY L. DODDS, Ph.D. (Pittsburgh)	Foods and Nutrition
JAMES W. DUNLOP, M.Mus. (Michigan)	Music Education
HOWARD W. DUNNE, Ph.D. (Michigan State)	Veterinary Science
GEORGE M. DUSINBERRE, M.S. (Columbia), P.E.	Mechanical Engineering
MARJORIE EAST, Ed.D. (Columbia)	Home Economics Education
PAUL EBAUGH, A.B. (Denison)	Engineering Research
CORTLAND EYER, Ph.D. (Northwestern)	Romance Languages
MERRELL R. FENSKE, D.Sc. (M.I.T.)	Chemical Engineering
CHARLES L. FERGUS, Ph.D. (Penn State)	Botany and Plant Pathology
JOHN H. FERGUSON, Ph.D. (Pennsylvania)	Political Science
HENRY A. FINCH, Ph.D. (Pennsylvania)	Philosophy
HUMMEL FISHBURN, Mus.D. (Montreal)	Music and Music Education
EDWIN R. FITZGERALD, Ph.D. (Wisconsin)	Physics
GEORGE H. FLEMING, Ph.D. (Penn State)	Chemistry
HAROLD K. FLEMING, M.S. (Penn State)	Pomology
PETER W. FLETCHER, Ph.D. (Missouri)	Forestry
KENT FORSTER, Ph.D. (Pennsylvania)	European History
HENRY R. FORTMANN, Ph.D. (Cornell)	Agronomy
LAWRENCE E. FOURAKER, Ph.D. (Colorado)	Economics
ROBERT W. FRANK, Jr., Ph.D. (Yale)	English
DONALD E. H. FREAR, Ph.D. (Penn State)	Agricultural and Biological Chemistry
ERNEST H. FREUND, Ph.D. (Freiburg)	Philosophy
JOHN C. FREY, Ph.D. (Iowa State)	Land Economics
HUBERT W. FRINGS, Ph.D. (Minnesota)	Zoology
ORRIN FRINK, Ph.D. (Columbia)	Mathematics
ROBERT F. GENTRY, Ph.D. (Michigan State)	Veterinary Science
JOHN J. GIBBONS, Ph.D. (Illinois)	Physics
MAURICE S. GJESDAHL, M.S. (Lehigh)	Mechanical Engineering
MAURICE K. GODDARD, M.S. (California)	Forestry
JOAN GORDON, Ph.D. (Minnesota)	Foods and Nutrition
WILLIAM H. GRAY, Ph.D. (Chicago)	Latin-American History
JOHN C. GRIFFITH, Ph.D. (Wales), D.I.C.	Petrography
ELMER A. GROSS, D.Ed. (Pittsburgh)	Physical Education
JOSEPH H. GROSSLIGHT, Ph.D. (Yale)	Psychology
ALVIN R. GROVE, Jr., Ph.D. (Chicago)	Botany
NOLLIE B. GUERRANT, Ph.D. (Missouri)	Biological Chemistry
LESTER P. GUEST, Ph.D. (Maryland)	Psychology
GEORGE M. GUTHRIE, Ph.D. (Minnesota)	Psychology
A. WILLIAM HAJJAR, M.Arch. (M.I.T.), R.A.	Architecture



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FRANCIS T. HALL, JR., M.S. (M.I.T.), P.E.  
 JOHN F. HALL, Ph.D. (Ohio State)  
 PHILIP F. HALLOCK, M.S. (Penn State), R.A.  
 IRENE E. HARMS, Ph.D. (Iowa)  
 ARTHUR L. HARNETT, JR., Ed.D. (Columbia)  
 BRICE HARRIS, Ph.D. (Harvard)  
 DALE B. HARRIS, Ph.D. (Minnesota)  
 HOWARD L. HARTMAN, Ph.D. (Minnesota), P.E.  
 HAZEL M. HATCHER, Ph.D. (Minnesota)

## *Home Economics Education and Home-Community Relationships*

WILLIAM M. HENCH, Ph.D. (Pennsylvania)  
 GRACE M. HENDERSON, Ph.D. (Ohio State)  
 WILLIAM L. HENNING, Ph.D. (Wisconsin)  
 G. WILLIAM HENNINGER, M.A. (N.Y.U.)  
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 DOROTHY HOUGHTON, Ph.D. (Columbia)  
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 MERWIN W. HUMPHREY, M.F. (Yale)  
 ALBERT S. HUNTER, Ph.D. (Rutgers)  
 A. W. HUSSMANN, Dr.Ing. (Technical University, Berlin), P.E.  
 A. WITT HUTCHISON, Ph.D. (Penn State)  
 ROBERT F. HUTTON, Ph.D. (Harvard)  
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 LOIS B. HYSLOP, Ph.D. (Wisconsin)  
 RICHARD H. JAHNS, Ph.D. (California Tech.)  
 CHARLES D. JEFFRIES, Ph.D. (Wisconsin)  
 MACKLIN E. JOHN, Ph.D. (Cornell)  
 EVAN JOHNSON, JR., Ph.D. (Chicago)  
 JOSEPH JORDAN, Ph.D. (Hebrew University, Jerusalem)  
 DONALD V. JOSEPHSON, Ph.D. (Penn State)  
 FRANK A. JOY, B.S. (New Hampshire)  
 LOUIS T. KARDOS, Ph.D. (Rutgers)  
 JACOB J. KAUFMAN, Ph.D. (Columbia)  
 MACKENZIE L. KEITH, Ph.D. (M.I.T.)  
 PAUL M. KENDIG, Ph.D. (Penn State)  
 PHILIP S. KLEIN, Ph.D. (Pennsylvania)  
 LEON R. KNEEBONE, Ph.D. (Penn State)  
 HENRY W. KNERR, Ph.D. (Michigan)  
 R. RUPERT KOUNTZ, M.S. (Iowa), P.E.  
 HARRY L. KRALL, Ph.D. (Brown)  
 FRANKLIN B. KRAUSS, Ph.D. (Pennsylvania)  
 DAVID A. KRIBS, Ph.D. (Yale)  
 PAUL D. KRYNINE, Ph.D. (Yale)  
 OTIS E. LANCASTER, Ph.D. (Harvard), P.E.  
 S. LEWIS LAND, Ph.D. (N.Y.U.)  
 RUSSELL E. LARSON, Ph.D. (Minnesota)  
 JOHN D. LAWThER, M.A. (Columbia), D.Pd.  
 WILLIAM M. LEPLEY, Ph.D. (Penn State)  
 LAURENT LESAGE, Ph.D. (Illinois)

*Electrical Engineering*  
*Psychology*  
*Architecture*  
*Child Development*  
*Physical Education*  
*English Literature*  
*Psychology*  
*Mining Engineering*  
  
*Economics*  
*Home Economics*  
*Animal Industry*  
*Music*  
*Soil Technology*  
*Pomology*  
*Electrical Engineering*  
*Meteorology*  
*Home Economics*  
*Geophysics*  
*Ceramic Technology*  
*Forestry*  
*Soil Technology*  
*Engineering Research*  
*Chemistry*  
*Farm Management*  
*History of Art and Architecture*  
*Romance Languages*  
*Geology*  
*Soil Technology*  
*Rural Sociology*  
*Mathematics*  
*Chemistry*  
*Dairy Science*  
*Engineering Research*  
*Soil Technology*  
*Economics*  
*Geochemistry*  
*Engineering Research*  
*American History*  
*Botany and Plant Pathology*  
*Physics*  
*Sanitary Engineering*  
*Mathematics*  
*Latin*  
*Botany*  
*Petrology and Sedimentation*  
*Engineering Education*  
*Industrial Education*  
*Horticulture*  
*Physical Education*  
*Psychology*  
*Romance Languages*

## PROFESSORS

ARTHUR O. LEWIS, JR., Ph.D. (Penn State)	English
FRED H. LEWIS, Ph.D. (Cornell)	Plant Pathology
ROBERT W. LINDSAY, Sc.D. (M.I.T.), P.E.	Metallurgy
JESSE E. LIVINGSTON, Ph.D. (Missouri)	Botany and Plant Pathology
A. PAULINE LOCKLIN, M.A. (Illinois)	English
GEORGE M. LOTT, M.D. (Colorado)	Psychiatrist
MIRIAM E. LOWENBERG, Ph.D. (Iowa), D.Sc.	Foods and Nutrition
ERNEST H. LUDWIG, Ph.D. (Pennsylvania)	Bacteriology
JOHN C. MAJOR, Ph.D. (Pennsylvania)	English Composition
M. FRANK MALLETT, Ph.D. (Columbia)	Agricultural and Biological Chemistry
FREDERICK B. MARBUT, Ph.D. (Harvard)	Journalism
PAUL H. MARGOLF, B.S. (Penn State)	Poultry Husbandry
JOSEPH MARIN, Ph.D. (Michigan), P.E.	Engineering Mechanics
JAMES W. MARKHAM, Ph.D. (Missouri)	Journalism
WILL E. MASON, Ph.D. (Princeton)	Economics
JOHN W. MASTALERZ, Ph.D. (Cornell)	Floriculture
ROY P. MATELSKI, Ph.D. (Michigan State)	Soil Technology
WILLIAM G. MATHER, Ph.D. (Cornell)	Sociology
FREDERICK R. MATSON, Ph.D. (Michigan)	Archaeology
EDWARD L. MATTEL, D.Ed. (Penn State)	Art Education
ARTHUR J. G. MAW, Ph.D. (Wisconsin)	Poultry Husbandry
DAVID R. McCLAY, Ph.D. (Cornell)	Agricultural Education
ROBERT E. McDERMOTT, Ph.D. (Duke)	Forestry
EUGENE T. McDONALD, D.Ed. (Penn State)	Speech and Speech Education
DONALD G. McGAREY, D.Ed. (Penn State)	Education
M. NELSON McGEARY, Ph.D. (Columbia)	Political Science
DAVID H. McKINLEY, M.A. (Penn State), LL.B.	Banking
ROBERT P. MEAHL, M.S. (Purdue)	Ornamental Horticulture
JOHN R. MENTZER, Ph.D. (Ohio State)	Engineering Sciences
WOLFGANG E. MEYER, Dipl.Ing.M.E. (Hannover)	Mechanical Engineering
E. WILLARD MILLER, Ph.D. (Ohio State)	Geography
FRANKLIN A. MILLER, Ph.D. (Pittsburgh)	Education
RUSSELL C. MILLER, Ph.D. (Cornell)	Animal Industry and Nutrition
WARREN W. MILLER, Ph.D. (California)	Chemistry
WILFORD R. MILLS, Ph.D. (Cornell)	Plant Pathology
DAVID R. MITCHELL, M.S. (Penn State), E.M., P.E.	Mining Engineering
JAMES E. MONTGOMERY, Ph.D. (Vanderbilt)	Housing and Home Art
MAURICE A. MOOK, Ph.D. (Pennsylvania)	Anthropology
WINONA L. MORGAN, Ph.D. (Minnesota)	Child Development and Family Relationships
JOHN A. MOURANT, Ph.D. (Chicago)	Philosophy
JAMES H. MOYER, Ed.D. (Columbia)	Education
ERWIN W. MÜLLER, Dr.Ing.habil. (Technical University, Berlin)	Physics
GEORGE E. MURPHY, D.Ed. (Stanford)	Education
ROBERT R. MURPHY, Ph.D. (Penn State)	Poultry Husbandry
ROBERT K. MURRAY, Ph.D. (Ohio State)	American History
G. KENNETH NELSON, Ph.D. (Illinois), C.P.A.	Accounting
MARGARET A. NEUBER, M.A. (Columbia)	Education
HANS NEUBERGER, D.Sc. (Hamburg)	Meteorology
FRANK S. NEUSBAUM, M.A. (Penn State)	Theatre Arts
BENJAMIN W. NIEBEL, M.S. (Penn State), I.E., P.E.	Industrial Engineering
RALPH F. NIELSEN, Ph.D. (Nebraska)	Petroleum and Natural Gas Engineering
CLARENCE I. NOLL, Ph.D. (Penn State)	Chemistry



NEWELL A. NORTON, Ph.D. (Michigan)	Wood Utilization
THOMAS S. OAKWOOD, Ph.D. (Penn State)	Chemistry
MARTIN L. ODLAND, Ph.D. (Minnesota)	Olericulture
ROBERT T. OLIVER, Ph.D. (Wisconsin), LL.D.	Speech
GEORGE U. OPPEL, Dr.Ing. (Technical University, Munich)	Engineering Mechanics
ELBURT F. OSBORN, Ph.D. (California Tech.)	Geochemistry
MILTON S. OSBORNE, M.S. (Columbia), LL.D., R.A.	Architecture
NUNZIO J. PALLADINO, M.S. (Lehigh), P.E.	Nuclear Engineering
HOWARD B. PALMER, Ph.D. (Wisconsin)	Fuel Technology
HANS A. PANOFSKY, Ph.D. (California)	Meteorology
JEROME K. PASTO, Ph.D. (Cornell)	Farm Management
ROBERT B. PATRICK, Ed.D. (Columbia)	Education
STUART PATTON, Ph.D. (Ohio State)	Dairy Science
LOUIS F. PECK, Ph.D. (Harvard)	English Composition
FRANK W. PEIKERT, M.S. (Iowa State)	Agricultural Engineering
RAYMOND PEPINSKY, Ph.D. (Chicago)	Physics
LAWRENCE J. PEREZ, M.C.E. (Brooklyn Polytech.), P.E.	Civil Engineering
CLARE W. PIERCE, Ph.D. (Cornell)	Agricultural Economics
RUTH L. PIKE, Ph.D. (Chicago)	Foods and Nutrition
GORDON H. PRITHAM, Ph.D. (Penn State)	Physiological Chemistry
ALFRED G. PUNDT, Ph.D. (Columbia)	European History
ELMER R. QUEER, M.S. (Penn State), P.E.	Engineering Research
DOROTHY QUIGGLE, Ph.D. (Penn State)	Chemistry and Chemical Engineering
JOHN R. RACKLEY, Ph.D. (George Peabody)	Education
STEPHEN M. RALEIGH, Ph.D. (Minnesota)	Agronomy
DAVID H. RANK, Ph.D. (Penn State), D.Sc.	Physics
JOSEPH G. RAYBACK, Ph.D. (Western Reserve)	American History
HAROLD J. READ, Ph.D. (Pennsylvania), P.E.	Physical Metallurgy
ARTHUR H. REEDE, M.A. (Penn State), D.Sc.	Economics
CALVIN G. REEN, M.S.E. (Michigan), P.E.	Civil Engineering
JAMES J. REID, Ph.D. (Wisconsin)	Bacteriology
J. W. CRANE REMALEY, Ph.D. (Pittsburgh)	Education
LOUIS A. RICHARDSON, M.S. (Penn State), P.E.	Architectural Engineering
A. CHESTER RICHER, Ph.D. (Penn State)	Soil Technology
JOHN D. RIDGE, Ph.D. (Chicago)	Mineral Economics
NEAL RIEMER, Ph.D. (Harvard)	Political Science
ARTHUR ROSE, Ph.D. (Cincinnati)	Chemical Engineering
RUSTUM ROY, Ph.D. (Penn State)	Geochemistry
JOSEPH J. RUBIN, Ph.D. (Yale)	American Literature
RUTH R. RUEF, Ph.D. (Cornell)	Family Economics and Housing
DAVID W. RUSSELL, Ph.D. (Western Reserve)	Education
HENRY W. SAMS, Ph.D. (North Carolina)	English
JOHN A. SAUER, Ph.D. (Cambridge)	Physics
ROGER B. SAYLOR, Ph.D. (Illinois)	Business Statistics
HAROLD K. SCHILLING, Ph.D. (Iowa), D.Sc.	Physics
CLAYTON H. SCHUG, M.A. (Ohio State)	Speech
RALPH P. SEWARD, Ph.D. (Brown)	Chemistry
WARD M. SHARP, Ph.D. (Washington U.)	Wildlife Management
ISADOR M. SHEFFER, Ph.D. (Harvard)	Mathematics
PHILIP A. SHELLEY, Ph.D. (Harvard)	German and Comparative Literature
SAMUEL SHULITS, M.S. (Michigan College of Mining and Tech.)	Civil Engineering
SIDNEY SIEGEL, Ph.D. (Stanford)	Psychology
RUTH C. SILVA, Ph.D. (Michigan)	Political Science



# PROFESSORS

PHILIP S. SKELL, Ph.D. (Duke)	Chemistry
EUGEN SKUDRZYK, Ph.D. (Berlin)	Engineering Research
ROBERT L. SLOBOD, Ph.D. (Northwestern)	Petroleum and Natural Gas Engineering
GRANT W. SMITH, Ph.D. (Minnesota)	Chemistry
KINSLEY R. SMITH, Ph.D. (Pennsylvania)	Psychology
WARREN S. SMITH, M.A. (Iowa)	Theatre Arts
WILLIAM M. SMITH, JR., Ph.D. (Cornell)	Family Relationships
WILLIAM U. SNYDER, Ph.D. (Ohio State)	Psychology
LEO H. SOMMER, Ph.D. (Penn State)	Chemistry
HERMAN M. SOUTHWORTH, A.B. (Cornell)	Agricultural Economics
CHARLES M. SPEIDEL, M.S. (Penn State)	Physical Education
THEODORE S. SPICER, Fuels E. (Penn State), P.E.	Fuel Technology
HOWARD B. SPRAGUE, Ph.D. (Rutgers)	Agronomy
VANCE G. SPRAGUE, Ph.D. (Wisconsin)	Agronomy
GLENN Z. STEVENS, Ph.D. (Minnesota)	Agricultural Education
ROBERT W. STONE, Ph.D. (Iowa State)	Bacteriology
RICHARD G. STONER, Ph.D. (Princeton)	Physics
RANDALL S. STOUT, Ph.D. (Pittsburgh)	Economics
EARL P. STRONG, Ed.D. (N.Y.U.)	Management
JOSEPH T. SULLIVAN, Ph.D. (Purdue)	Phytochemistry
SHIOU-CHUAN SUN, Sc.D. (M.I.T.)	Mineral Preparation
A. BRUCE SUTHERLAND, Ph.D. (Pennsylvania)	English Literature
FRANK M. SWARTZ, Ph.D. (Johns Hopkins)	Paleontology
ROBERT W. TAFT, JR., Ph.D. (Ohio State)	Chemistry
HAROLD I. TARPLEY, M.S. (Illinois), P.E.	Electrical Engineering
WILLA C. TAYLOR, M.A. (N.Y.U.)	Music
GLENN N. THIEL, M.Ed. (Penn State)	Physical Education
S. EARL THOMPSON, D.Ed. (Illinois)	Hotel and Institution Administration
GEORGE L. THUERING, M.S. (Penn State), M.E., P.E.	Industrial Engineering
HOWARD O. TRIEBOLD, Ph.D. (Minnesota)	Agricultural and Biological Chemistry
O. FRANK TUTTLE, Ph.D. (M.I.T.)	Geochemistry
ABRAM W. VANDERMEER, Ph.D. (Chicago)	Education
EDWARD B. VANORMER, Ph.D. (Columbia)	Psychology
DOROTHY H. VEON, Ed.D. (Columbia)	Education
ROBERT K. VIERCK, M.S. (Iowa), P.E.	Engineering Mechanics
CARL VOLZ, Ph.D. (Penn State)	Electrical Engineering
HERBERT A. WAHL, Ph.D. (Penn State)	Botany
PHILIP L. WALKER, JR., Ph.D. (Penn State)	Fuel Technology
WALTER H. WALTERS, Ph.D. (Western Reserve)	Theatre Arts
THOMAS WARTIK, Ph.D. (Chicago)	Chemistry
JOHN B. WASHKO, Ph.D. (Wisconsin)	Agronomy
R. HADLY WATERS, Ph.D. (Pennsylvania)	Transportation
ARTHUR WAYNICK, Sc.D. (Harvard)	Electrical Engineering
WAYNE WEBB, Ph.D. (Iowa)	Physics
WINSTON R. WEISMAN, Ph.D. (Ohio State)	History of Art and Architecture
ARTHUR M. WELLINGTON, M.A. (Ohio State)	Counselor Education
CLIFFORD C. WERNHAM, Ph.D. (Cornell)	Plant Pathology
WOLDEMAR WEYL, Dr.Ing. (Aachen)	Physical Science
RALPH H. WHERRY, M.A. (Penn State), C.I.U.	Insurance
BENJAMIN A. WHISLER, Sc.D. (Harvard), P.E.	Civil Engineering
WALLACE E. WHITE, Ph.D. (Yale)	Wood Technology
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WILLIAM R. MONAT, Ph.D. (Minnesota)	Political Science and Public Administration
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REED T. PHALAN, J.D. (Michigan Law)	Business Law
MILES T. PIGOTT, Ph.D. (Penn State)	Engineering Research
ROBERT M. POCKRASS, Ph.D. (Stanford)	Journalism
WILLIAM W. PRATT, Ph.D. (Iowa State)	Physics
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RICHARD O. ROWLANDS, M.Sc. (Wales)	Engineering Research
RADHA R. ROY, Ph.D. (London)	Physics
CHARLES W. RUTSCHKY, Ph.D. (Cornell)	Entomology
OWEN H. SAUERLENDER, Ph.D. (Minnesota)	Economics
CARL J. SCHAEFER, Ph.D. (Ohio State)	Industrial Education
JOHN J. SCHANZ, JR., Ph.D. (Penn State)	Mineral Economics
MARTIN W. SCHEIN, Sc.D. (Johns Hopkins)	Animal Behavior
JOHN M. SCHEMPF, Ph.D. (Cornell)	Chemistry
ERWIN R. SCHMERLING, Ph.D. (Cambridge)	Electrical Engineering
LOWELL SCHOENFELD, Ph.D. (Pennsylvania)	Mathematics
ROBERT SCHOLTEN, Ph.D. (Michigan)	Petroleum Geology
WILLIAM J. SCHRADER, D.B.A. (Washington), C.P.A.	Accounting
PAUL E. SHIELDS, M.S. (Pittsburgh), E.E., P.E.	Electrical Engineering
JAMES W. SHIGLEY, Ph.D. (Penn State)	Agricultural and Biological Chemistry
ALBERTA E. SIEGEL, Ph.D. (Stanford)	Child Development
BRUCE M. SIEGENTHALER, Ph.D. (Michigan)	Clinical Speech
CYRIL B. SMITH, Ph.D. (Penn State)	Plant Nutrition
GORDON R. SMITH, Ph.D. (Penn State)	English
WILLIAM SPACKMAN, JR., Ph.D. (Harvard)	Paleobotany
C. DREW STAHL, Ph.D. (Penn State)	Petroleum and Natural Gas Engineering
F. BRISCOE STEPHENS, Ph.D. (Penn State)	Meteorology
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LOREN D. TUKEY, Ph.D. (Ohio State)	Pomology
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VLADIMIR VAND, D.Sc. (Glasgow)	Physics
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HAROLD V. WALTON, M.S. (Penn State)	Agricultural Engineering
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LAWRENCE L. WERBOFF, Ph.D. (Stanford)	Economics
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DOUGLAS F. WHITE, Ph.D. (Penn State)	Mechanical Engineering
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THOMAS A. WIGGINS, Ph.D. (Penn State)	Physics
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HAROLD G. MARSHALL, Ph.D. (Minnesota)	Agronomy
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WILLIAM A. STEELE, Ph.D. (Washington)	Chemistry
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EUGENE G. WILLIAMS, Ph.D. (Penn State)	<i>Geology</i>
DONALD J. WILLOWER, Ed.D. (Buffalo)	<i>Education</i>
CLYDE J. WINGFIELD, D.P.A. (Syracuse)	<i>Political Science and Public Administration</i>

## INSTRUCTORS

HENRY S. ALBINSKI, Ph.D. (Minnesota)	<i>Political Science</i>
HENRY D. GERHOLD, Ph.D. (Yale)	<i>Forestry</i>
WILLIAM E. SOPPER, Ph.D. (Yale)	<i>Forestry</i>

## OTHER MEMBERS OF THE GRADUATE FACULTY

JOSEPH ALESSANDRO, D.Ed. (Penn State)	<i>Education</i>
CHRISTINE AYOUB, Ph.D. (Yale)	<i>Mathematics</i>
LELAND L. BEIK, Ph.D. (Columbia)	<i>Marketing</i>
OSWALD D. BOWLIN, Ph.D. (Illinois)	<i>Finance</i>
ALFRED J. ENGEL, B.Ch.E. (Cornell)	<i>Chemical Engineering</i>
RICHARD A. GOTSHALK, Ph.D. (Northwestern)	<i>Philosophy</i>
LESLIE P. GREENHILL, B.Com. (Melbourne)	<i>Academic Research and Services</i>
KENNETH W HYLBERT, D.Ed. (Penn State)	<i>Rehabilitation Counseling</i>
OSCAR A. KIMMEL, M.S. (Penn State)	<i>Farm Mechanics</i>
J. CAMPBELL LESTER, M.S. (Penn State), P.E.	<i>Mechanical Engineering</i>
NELL A. MURPHY, D.Ed. (Stanford)	<i>Education</i>
AMOS E. NEYHART, M.S. (Penn State)	<i>Institute of Public Safety</i>
HOBSON PITTMAN (Member of National Academy)	<i>Visiting Artist</i>
DELLA M. ROY, Ph.D. (Penn State)	<i>Geochemistry</i>
HARALD SCHRAER, Ph.D. (Cornell)	<i>Biophysics</i>
JOHN M. SHEMA, M.A. (Michigan State)	<i>Industrial Arts Education</i>
BURTON E. VOSS, Ph.D. (Iowa)	<i>Education</i>
WALTER F. WESTERFELD, M.S. (Penn State)	<i>Botany</i>
MARTIN L. ZEIGLER, Ph.D. (Penn State)	<i>Student Affairs Research</i>





# GENERAL INFORMATION

GRADUATE WORK at The Pennsylvania State University was first offered in 1862 when two graduate students were in residence. It was given more formal recognition in 1864 by the establishment of a "course for Graduates" designed for students who, after receiving the degree of Bachelor of Scientific Agriculture, wished to do advanced work leading to the degree of Master of Scientific Agriculture. For some time there were few graduate students, and graduate instruction was relatively unorganized. Later a committee of the University Senate was given the responsibility of establishing standards and regulations governing graduate work and the granting of advanced degrees. The Graduate School was organized in 1922. Until this time only masters' degrees and certain technical degrees had been conferred. In 1924, the Board of Trustees authorized the granting of the degree of Doctor of Philosophy. Still later other degrees were approved.

The faculty of the Graduate School consists of the President and certain other general administrative officers of the University, the Deans, the Librarian, the heads of departments, and those members of the instructional staff who have been authorized by the proper agencies of the Graduate School to offer graduate courses and supervise research leading to theses. It controls all academic matters pertaining to the Graduate School, subject to review by the University Senate.

The Graduate Faculty has approximately 700 members. Graduate student enrollment was about 2,300 per semester in 1959-60 and about 3,055 during the summer of 1960. The number of advanced degrees conferred in 1959-60 was 734, of which 149 were doctorates.

CO-OPERATIVE ARRANGEMENTS WITH OTHER INSTITUTIONS—A working arrangement has been established with Jefferson Medical College of Philadelphia whereby a candidate for an advanced degree at Jefferson may do part of his graduate work at Penn State by scheduling relevant courses and research at University Park. Similarly a graduate student with an appropriate major at Penn State may earn credits at Jefferson which, upon advance approval by his major department, will be accepted in partial fulfillment of degree requirements at Penn State.

A co-operative agreement with the University of Pittsburgh enables a student at Penn State to spend one semester taking courses and doing field work at the Graduate School of Public Health of the University of Pittsburgh in partial fulfillment of the requirements for the degree of Master of Science with a major in Nutrition in Public Health.

## PROCEDURES AND REGULATIONS

A student is expected to assume full responsibility for knowing the regulations and pertinent procedures of the Graduate School as set forth in this publication, the *Manual for Graduate Students*, and the *Thesis Information Bulletin*, and for meeting the standards and requirements expressed by these regulations. The *Manual*, which is available to a student after he has been admitted, sets forth in more detail the procedures governing registration, changes in program, and graduation, and gives other information about the Graduate School which is useful to graduate students. Every student should secure a copy of this manual from the Dean's office as soon after admission as possible.

## ADMISSION

An applicant for admission to the Graduate School should understand that graduate work is not simply an extension of undergraduate work. It operates at a definitely higher level, demands scholarship of a high order, and emphasizes research and cre-

## ADMISSION

ativity. It involves a minimum of formal requirements and regulations, and a maximum of student initiative and responsibility.

A student does not become a graduate student merely by enrolling for advanced courses after having received a baccalaureate degree. Formal admission to the Graduate School is required. Credits earned before admission cannot be applied to meet degree requirements at a later date even though admission may have been granted in the meantime.

Admission is granted by the Dean of the Graduate School after approval of the application by the department in which the student plans to do his major work. Blanks to be used in making formal application for admission can be obtained from the Graduate School office. In general, a student may begin his graduate work in fall, winter, spring, or summer. Prospective students may write directly to the head of any department concerning graduate work in that specific field.

Students from other countries are encouraged to write to the Director of International Student Affairs for information concerning finances, housing, and other non-academic matters.

**CREDENTIALS**—An applicant for admission should provide complete credentials, in duplicate, sent directly from other institutions to the Dean of the Graduate School at least six weeks prior to the opening of the term in which he plans to begin his graduate program. If the applicant has attended more than one institution, two official transcripts of the work covered at each institution are required. This applies to the complete academic record, both undergraduate and graduate.

**UNQUALIFIED ADMISSION**—For unqualified admission to the Graduate School an applicant must have received a baccalaureate degree from an accredited institution, earned under residence and credit conditions substantially equivalent to those required by The Pennsylvania State University. He must have maintained during his junior and senior years a minimum grade point average equivalent to 2.5 on The Pennsylvania State University grading scale (approximately half B and half C). Finally, he must ordinarily have completed in a satisfactory manner a certain minimum of course work in designated areas, the specific courses and amount of required work depending upon the field of advanced study which the student proposes to enter. The minimum grade point average of 2.5 during the last two undergraduate years is a general requirement of the Graduate School. Individual departments may require a higher average for admission in their fields.

**CONDITIONAL ADMISSION**—Some divisions are participating in an experiment on conditional admission for applicants whose undergraduate grade point average is below 2.5 but whose qualifications in other respects seem to suggest probable success in the Graduate School. Such an applicant must realize that the initiative rests entirely with him in communicating with the department of his chosen major and that, if admitted conditionally, he does graduate work at his own risk. There is no assurance that he will subsequently be granted unqualified admission or that the credits earned will automatically be applied toward degree requirements. Applicants for admission on a conditional basis must have all of the essential materials for consideration for admission to that status on file with the Dean of the Graduate School at least six weeks before they wish to register in the Graduate School.

**PROVISIONAL ADMISSION**—Provisional admission may be granted to an applicant whose complete credentials are not available at the time of registration, but this admission will be subject to cancellation if the credentials, on their arrival, do not meet the requirements for admission to the Graduate School. Also, while the applicant is holding provisional admission, certification of any scheduled credits will be withheld until receipt of his official credentials makes possible his unqualified admission to the Graduate School. If the provisional admission should, for any reason,



be canceled, the student is thereby automatically dropped from the Graduate School and as a consequence will be required to cease attending any 500-level courses for which he may have registered. He may continue to attend 400-level courses provided he applies for and is accepted for registration as a special student.

A student with a slight deficiency in undergraduate preparation may be admitted and allowed to take a limited number of undergraduate courses to make up the deficiency while proceeding with his graduate program. Courses taken for this purpose do not, of course, apply toward the requirements for an advanced degree.

**READMISSION**—Formal readmission is not required year by year nor after one or more semesters of absence from the campus unless the student has completed more than 12 credits of work at another institution in the meantime. In this case readmission is required, and evidence of good standing at the institution involved is essential. A student who has earned a master's degree at The Pennsylvania State University should not register for further degree work until his academic record and personal qualifications have been reviewed critically by the department of his major interest and a candidacy evaluation has been completed.

**GUESTS OF THE UNIVERSITY**—The President of the University, on recommendation of the Dean of the Graduate School, will welcome doctors of philosophy of The Pennsylvania State University, as well as those of other accredited colleges and universities, as guests of the University, with the privilege of attending seminars and courses and of carrying on research. There will be no charge except for laboratory expenses. Arrangements should be made in advance with the Dean of the Graduate School.

**UNDERGRADUATE STUDENTS**—A senior student of The Pennsylvania State University lacking not more than 4 credits for graduation may be admitted to the Graduate School. This limit may be increased to 8 credits in the case of a student with an average of at least B (a grade point average of 3). Any senior with a 3.5 grade point average may be admitted to 500-level courses with the consent of the instructor; other undergraduate students may be admitted to such courses with the consent of the instructor and the Dean of the Graduate School. Those not admitted to the Graduate School cannot use these credits toward an advanced degree.

## CLASSIFICATION

At the time of admission to the University students are classified as regular graduate, general graduate, special, or undergraduate students depending upon their objectives and qualifications.

Changes in classification are arranged through the Graduate School office and, in the case of a change from general to regular status, the approval of the head of the major department in which the student proposes to work is required.

A person holding a baccalaureate degree and working only for permanent certification as a teacher or administrator in the public schools is advised to apply for admission as a general graduate student.

**REGULAR GRADUATE STUDENTS**—Persons who plan to become candidates for advanced degrees at The Pennsylvania State University and have been formally admitted for advanced study in a particular field are designated as regular graduate students. The program of study is developed under the guidance of a department head or his representative.

It should be emphasized that a student is not a "regular graduate student" unless he has been officially admitted to that status. Regular attendance in the Graduate School, or personal plans for future degree candidacy, do not in themselves carry with them the status or privileges of a regular graduate student.



## REGISTRATION

A regular graduate student who has passed a candidacy evaluation is classified as a doctoral candidate.

**GENERAL GRADUATE STUDENTS**—An applicant who meets all requirements for admission to the Graduate School, but who does not wish to work for an advanced degree at this institution, may arrange for a program of work as a general graduate student. This classification includes those who plan to transfer credits to another institution and those who plan a special program of study not leading to an advanced degree.

The adviser for a general graduate student is appointed by the department head most closely associated with the student's field of interest. The student's status and standing will be reviewed by the Dean of the Graduate School at each registration. He may not remain a general graduate student longer than one semester (or summer sessions totaling 12 weeks) except with the permission of the Dean, and for definite and good reasons.

When a general graduate student wishes to become a regular graduate student—i.e., to work for an advanced degree at this institution—he should make application to the Dean of the Graduate School for change of status. His undergraduate record will then be re-evaluated to determine whether or not he is prepared to undertake graduate work for a degree in the major field of his choice. He should understand that he may thereafter apply toward degree requirements only those credits earned as a general graduate student which fit definitely and logically into an integrated degree program. There is no upper limit to the number of credits that may be so applied; neither is there a guarantee that any such credits may be applicable.

**SPECIAL STUDENTS**—A special student is not a graduate student, inasmuch as he has not been admitted to the Graduate School, and may not register for graduate courses or research (500 and 600 series) without permission of the Dean of the Graduate School. A special student may register for 400-level courses, provided he has attained at least junior standing in college. Except for most unusual reasons, a special student who is later admitted to the Graduate School may not then count toward degree requirements any credit he has earned while in the special student status.

## REGISTRATION

The responsibility for being properly registered rests with the student. At least until he has met the minimum requirements for his degree, he must register for each term in which he proposes to do either course work or research, or other work on his thesis, either on or off campus. In the case of research the number of credits shall be determined by the amount of time required for the investigation, one credit representing one week of full-time graduate work.

**PROCEDURE**—For each registration the student, in consultation with his adviser, prepares a schedule of courses and research designed to fit his individual needs, which is submitted to the Dean of the Graduate School for his approval. The registration process is completed in the manner specified for all students at the University.

Under certain conditions credit may be earned by work done off the campus. A student contemplating such work should inquire of the Dean of the Graduate School about the procedures and conditions. Such work must be scheduled *in advance* in the regular manner.

A resident student is required to register in person, not by proxy. A nonresident student is expected to assume responsibility for initiating the registration process, but the details can be handled by mail. A student must register for courses audited as well as for those taken for credit.

**EXCEPTIONS**—When a candidate has met minimum requirements for a degree, further registration shall be required only for course work, project work, and research work requiring the use of University facilities and supplies (including laboratory, library, and others). This means, for instance, that if a student has completed three years of work (90 credits) of a doctoral program, has completed his research on campus, and has permission from the Dean to complete his work *in absentia*, he need not register for credits. Similarly, a student who has earned 90 credits, but who still has much research to do which does *not* involve using University facilities, and who receives permission to complete his work at, for example, the Library of Congress, need not register. On the other hand, a student who uses University facilities for all of his research must be registered for credit at all times, regardless of the number of credits that may accrue before he completes his work.

A candidate does not need to register for the term at the end of which the degree is to be conferred solely for the purpose of graduating. He will, of course, be required to register if he has a significant amount of work to complete unless relieved of this obligation by the previous paragraph. He will not be required to register if he has only minor revisions of his thesis to complete and/or the final oral examination to pass.

**TIME OF REGISTRATION**—The regular registration days are indicated in the University Calendar. Graduate students follow the same registration schedule as undergraduates do.

A student is expected to complete his registration during the officially designated period and to attend the first meeting of all classes in which he is enrolling. If this is impossible because of some emergency or unusual circumstance beyond his control, the student may be granted permission by his instructors to miss a few class meetings, it being understood that work missed will be made up subsequently. Under these conditions the Dean of the Graduate School may grant the student permission to register late. In general, a student who receives permission to register late will be required to reduce his program in proportion to the amount of time which he has been absent.

Regardless of when he may begin attending classes, a student who fails to complete the process of registration within the officially designated registration period will be liable for the late registration fee.

**LOADS, ACADEMIC AND EMPLOYMENT**—Many students depend upon part-time employment to help meet their expenses. A student who is thus employed, however, must recognize the time demands of his work schedule in planning his academic program.

The University takes the position that the facilities of the Graduate School should be made available only to students who can profit from their Graduate School experience to a maximum extent. Therefore the Graduate School reserves the right to deny admission or registration to part-time students who (a) propose schedules of few credits which seem to reflect little real interest in graduate work or would not seem to require serious effort, or (b) wish to carry overloads of such proportion as to handicap them seriously in achieving maximum quality in their graduate work.

“Doing graduate work” means more than doing what is required in courses or in research. It means living in a scholarly atmosphere and seriously engaging in scholarly pursuits. It means profiting from hearing visiting scholars and artists and from engaging in discussions, both formal and informal, with faculty members and fellow students. It should mean leisure time for reflection and for exploring fields related to, although not directly a part of, one’s specialty. Overloads make it difficult and often impossible to do graduate work so conceived. Hence the following “protective” schedule of permitted loads for students who are employed has been adopted:



## AUDITING CLASSES

EMPLOYMENT		CREDITS ALLOWED	
<i>Hours per Week</i>	<i>Percentage of Full Time</i>	<i>Credits</i>	<i>Percentage of Full Load</i>
0	0	15	100
10	25	11-13	80
20	50	8-10	60
30	75	6- 8	50
40	100	6	40

This means, for example, that anyone working 20 hours per week (about half-time) whether as a half-time graduate assistant, as an employee on campus, or as an employee off-campus, will be limited in the amount of graduate work for which he may register to about three fifths (or 60 per cent) of a normal full-time load (i.e., to 8-10 credits). The term employment is used in a very general sense and includes working for indirect compensation, such as housekeeping, working in the family business, maintaining a large vegetable garden, etc. Hence, all students who are thus employed will be expected to adjust their academic loads accordingly. Exceptions, in the case of students who have demonstrated unusual ability, must be arranged with the Dean of the Graduate School at the time of registration. (See also Auditing and Visiting Classes.)

A student holding a fellowship, graduate assistantship, or scholarship is not permitted to accept employment of any kind for service beyond that specified by his appointment.

**AUDITING AND VISITING CLASSES**—A regularly registered graduate student who wishes to take a course without credit may be allowed to do so upon securing the permission of the instructor in the course and the approval of the Dean of the Graduate School. Such a student, known as an auditor, may, if he wishes, participate in class discussion, do practicum work, submit written work, and take examinations. He must register for the course in the same manner as if he were taking the course for credit and must pay tuition on the same basis. He receives no grade in the course and cannot subsequently claim any sort of credit for work done in the course. Ordinarily a student is required to count the courses audited as a part of his normal credit load.

A regularly registered student of the Graduate School may at any time during a regular term visit, with the permission of the instructor, a class for which he is not registered. Under this provision the student may not claim the usual privileges of class membership, such as participating in class discussion, doing practicum work, submitting written work, and taking examinations. This privilege is officially designated as "visiting classes without registration," and no record of it appears on the student's transcript.

**STATUS UNDER SELECTIVE SERVICE**—As soon as an applicant has been admitted to the Graduate School, his local board will be informed *provided* the applicant requests it and has given the necessary information. As soon as he receives notification of admission, the applicant should check with the Associate Registrar to see that everything is in order.

A student is certified to be a full-time student insofar as Selective Service is concerned if he schedules at least 12 credits in a semester, if he holds an appointment as a quarter-time or half-time graduate assistant, or if he is serving an internship under approved conditions.

Whenever a student changes his status so as no longer to be considered a full-time student, fails to make satisfactory progress, or makes a drastic change in his declared goal, his local board will be notified.



## GRADING SYSTEM

A grade is given solely on the basis of the instructor's judgment as to the student's scholarly attainment.

For graduate courses (500 series) and for research or thesis (600 or 610) one of three grades may be given:

H for Honors, indicating definitely superior attainment.

P for Pass, indicating acceptable but not superior attainment.

F for Fail, indicating failure to attain the acceptable minimum standard of work or to spend an adequate amount of time doing the work scheduled.

In addition to the quality grades listed above, two symbols, "deferred" and R, may appear on a student's transcript. If work is incomplete at the end of a term for a reason beyond the student's control, or if very little work remains to be done, the instructor may report "deferred" in place of a grade, which will appear temporarily on the student's record.

In the case of thesis work, either in progress or completed, the instructor may report the symbol R in place of a grade. This symbol indicates that the student has devoted an adequate amount of time to the work scheduled but gives no indication of its quality. An R remains on the student's transcript permanently. If, after having submitted a series of R symbols, the instructor reports a grade of H, P, or F for a specific session, this grade is considered to apply to the preceding series of registrations and to denote the quality of that entire series.

For 400 series courses one of five grades may be given:

<i>Grade</i>	<i>Percentage Equivalent</i>	<i>Grade Point Equivalent</i>
A	90-100	4
B	80- 89	3
C	70- 79	2
D	60- 69	1
F (Failure)	0- 59	0

Grades below B do not carry graduate credit and are considered failures in the program of a graduate student.

## GRADUATION

It is the responsibility of the student to inform the Graduate Recorder of his intention to graduate, and to pay thesis fees at the beginning of the semester or term when he expects to receive an advanced degree. Deadlines are given in the calendar on pages 3 and 4.

All degrees conferred are tentative until final grade reports have been received even though the student's name may have appeared in the commencement program.

Attendance at commencement exercises is an obligation on the part of those receiving advanced degrees. A request to receive the degree *in absentia* may be presented to the Dean of the Graduate School, but only under unusual circumstances will it be granted. See the *Manual for Graduate Students* for a detailed statement of procedure.

## TUITION AND LIVING ACCOMMODATIONS

The University reserves the right to revise the schedule of tuition and charges without further notice. Because the University will operate on a four-term system beginning in the summer of 1961, the fees quoted below are given for a semester and, in parentheses, for a term.

## TUITION

### TUITION

*Residents of Pennsylvania*, \$20 per credit with a maximum of \$240 per semester (\$160 per term).

*Nonresidents of Pennsylvania, on-campus work*, \$40 per credit with a maximum of \$480 per semester (\$320 per term).

*Nonresidents of Pennsylvania, research in absentia*, \$20 per credit with a maximum of \$240 per semester (\$160 per term).

*Total charge for Vocational Education courses* (indicated by "v" following the course number), \$20.

Tuition is the same for courses whether taken as an auditor or for credit.

*Special Charges* (payable as occasion demands and applicable to all students):

Admission to the Graduate School . . . . .	\$10.00
Privilege of late registration or late payment . . . . .	10.00
Change of schedule, each change . . . . .	2.00
Microfilming of doctoral thesis and publication of abstract . . . . .	35.00
Minimum fee for binding of thesis, per copy . . . . .	3.00
Official transcript of record (with seal), each copy . . . . .	1.00

Any student who does not fulfill payment obligations promptly may be charged \$1 for each day of delinquency up to and including five days, or a maximum of \$10 if the delinquency exceeds five days. A student whose account is delinquent for more than 10 days is subject to suspension from the University.

Whenever it shall appear from any of the information presented as part of the application for admission that the applicant is not domiciled in Pennsylvania, the Dean of Admissions, when admission is granted to that applicant, assumes that the one admitted is a non-Pennsylvanian and includes that admission as a part of the established out-of-State quota. If the student who is thus admitted believes that his circumstances do not justify his classification as a non-Pennsylvanian, he may petition the Dean of Admissions for reclassification.

When a petition for reclassification is made, the petitioner is required to present proof of a bona fide continuous domicile of the one admitted (or of his parents, if he is a minor) within the Commonwealth for a period of at least 12 months immediately preceding the date of such petition for reclassification; and, in addition, such other evidence as is pertinent to a complete review of his classification.

Any student who changes his domicile while attending the University is subject to reclassification effective at the beginning of the first term following the twelfth month after such change has taken place.

**REFUNDS OF CHARGES FOR TUITION**—Charges for tuition are refundable in part upon withdrawal from the University provided the student obtains the Official Withdrawal Form at the office of the Dean and presents it to the office of the Fee Assessor not later than one calendar month after the effective date of withdrawal from classes. Refunds for a semester are made according to the following schedule.

90 per cent refund upon withdrawal before the end of the first week of classes and a decrease of 10 per cent for each consecutive calendar week thereafter up to and including the 9th consecutive week. No amount will be refunded upon withdrawal after the 9th consecutive calendar week of the semester. (This is subject to revision under the term system.)

**LIVING ACCOMMODATIONS**—Eastview Terrace and Graduate Circle, both located on the eastern side of the campus, provide one- and two-bedroom apartments for married graduate students.

The Eastview Terrace apartments are fireproof, one-story, steel framework buildings. Forty-six one-bedroom units rent for \$65 per month and 32 two-bedroom units rent for \$75. The rent includes utilities except for electricity. Hot water is heated



electrically. The units are unfurnished except for electric stove and refrigerator. For each two units, there is a utility room with two stationary laundry tubs and storage space.

Graduate Circle, opened in 1960, has 144 one-bedroom and 72 two-bedroom apartments in 16 two-story buildings of brick and frame construction. The units rent for \$82.50 and \$92.50 per month, including all utilities. The kitchens have double stainless steel sinks with disposal unit, a gas stove, kitchen cabinets, electric refrigerator, and a built-in chest of drawers in the bedroom; otherwise the units are unfurnished. There are no facilities for private washing machines in the apartments; however, coin-operated laundries at nominal fees are provided in five of the buildings throughout the area. A storage locker is also provided for each apartment at the laundry location.

Families with children of school age cannot be considered for occupancy. The one-bedroom apartments are designed for a husband and wife and the two-bedroom units for a family with not more than two children. An application form for a Married Student Apartment may be obtained by writing to the Department of Housing, Pollock Dining Hall, The Pennsylvania State University, University Park, Pa.

A married student may also find accommodations in off-campus apartments, trailers, or rooms in private homes. Personal contact is essential, but assistance may be gained from the Graduate Student Association, the Office of the Dean of Men, or an advertisement in the local newspaper. The Housing Committee of the Graduate Student Association concentrates on providing lists and descriptions of known vacancies in apartments. The Committee may be addressed at 210 Hetzel Union Building, University Park, Pa.

Graduate Hall and Grange Hall, both located on central campus, provide for single students, both men and women. For detailed information write to Department of Housing, Pollock Dining Hall, The Pennsylvania State University, University Park, Pa. Other living accommodations are available, including rooms in private homes and lodging houses. The cost varies considerably depending upon the type of accommodation. A list of known vacancies is maintained by the offices of the Dean of Men and the Dean of Women. The prospective student should write to the appropriate office well in advance of the beginning of classes because it may be very difficult to find a convenient location at the last minute. Boarding houses, restaurants, and the Hetzel Union Cafeteria on the campus are available for meals.

## STUDENT AIDS AND SERVICES

In every case in which a graduate assistantship, scholarship, or fellowship for the next academic year is offered to an actual or prospective graduate student, the student, if he indicates his acceptance before April 15, will have complete freedom through April 15 to submit in writing a resignation of his appointment in order to accept another graduate assistantship, scholarship, or fellowship. However, an acceptance given or left in force after April 15 commits him not to accept another appointment without first obtaining formal release for the purpose.

**ASSISTANTSHIPS**—Approximately 800 graduate assistantships are awarded annually. Most of these are half-time, but a limited number of quarter-time and three-quarter-time assistantships are available in some departments.

The assistantships vary in stipend, service required, and the number of credits for which a student may register, as follows:

**QUARTER-TIME**, requiring about 10 hours of service per week.

For the academic year: stipend \$657-\$1,125; 11-13 credits per semester.

For the fiscal year: stipend \$876-\$1,500; 11-13 credits per semester, 8-9 credits in summer sessions.



## STUDENT AIDS

**HALF-TIME**, requiring about 20 hours of service per week.

For the academic year: stipend \$1,314-\$2,250; 8-10 credits per semester.

For the fiscal year: stipend \$1,752-\$3,000; 8-10 credits per semester, 6-8 credits in summer sessions.

**THREE-QUARTER-TIME**, requiring about 30 hours of service per week.

For the academic year: stipend \$1,971-\$3,375; 6-8 credits per semester.

For the fiscal year: stipend \$2,628-\$4,500; 6-8 credits per semester, 4-6 credits in summer sessions.

In addition to the stipend listed above each graduate assistant receives a grant-in-aid which covers tuition but not the special charges such as admission, late registration, and change of schedule.

A prospective student should write directly to the head of his major department for information and application forms. Appointments are made upon the recommendation of the department head, subject to admission to the Graduate School. Clear evidence of superior ability and promise is required. Reappointment to an assistantship requires a continuing demonstration of good scholarship.

An appointee may serve as an assistant in classroom or laboratory instruction, or in research or other work. Vacation for a graduate assistant consists of the regular student vacations available to all graduate students.

A graduate assistant may not accept additional employment, either at the University or elsewhere, during the period for which service to the University is required under the appointment.

A student holding a quarter-time or a half-time assistantship is considered to be following a full-time course of instruction under Selective Service regulations and is so certified to his local draft board. A student holding a three-quarter-time assistantship is not considered to be following a full-time course of instruction.

**COUNSELORSHIPS FOR MEN**—A number of appointments are available to male students to serve as resident counselors in the undergraduate residence halls for men. A counselor's responsibility is to work for the social, academic, and emotional adjustment of the undergraduate residents. Specialized training in personnel work is desirable, though not essential.

These appointments are for the academic year and carry with them remission of charges for room and board, but not exemption from tuition, except that all counselors pay the same tuition as would residents of Pennsylvania. A counselor may not hold a fellowship, a graduate assistantship, or a graduate grant-in-aid during the term of his appointment as counselor; he may carry only 12 credits per semester. After completing two semesters of successful service as a counselor, he may be reappointed with the addition of a grant to cover half of his tuition.

Applications and requests for information should be addressed to the Dean of Men.

**SENIOR RESIDENTS FOR WOMEN**—A few part-time appointments and a number of full-time appointments are available to women graduate students as senior residents in undergraduate residence halls for women. Six or more credits of academic work per semester may be carried, depending upon the work load. Compensation varies with responsibilities and training.

Applications and request for information should be addressed to the Dean of Women.

**FELLOWSHIPS**—More than 100 fellowships are awarded annually. Recipients must be superior students and are frequently required to have completed a certain minimum of graduate work before being eligible for an award. Fellows carry a full-time graduate program, receive a stipend which varies with the award, and receive a grant-in-aid paid by the donor of the fellowship to provide for all tuition charges. They may not accept employment during the term of their appointment, nor are they required to render any service to the University. In some cases a fellow will be

expected to limit his research to a broad field specified by the donor. Fellows are required to pay specific charges such as admission, late registration, change of schedule, and thesis binding and microfilming fees.

**GRADUATE SCHOOL FELLOWSHIPS**—Eleven fellowships, each paying a stipend of \$2,000 and providing a grant-in-aid to cover all tuition charges for the academic year, are given by the University and are designated as Graduate School Fellowships. They are available to outstanding advanced graduate students in any field, although preference is given to applicants majoring in the humanities and social sciences. An applicant must have completed at least one full year of graduate study prior to beginning the fellowship tenure and be a candidate for the doctoral degree.

Applications should be addressed to the Dean of the Graduate School and must be received by March 1 in order to be considered for the following academic year.

**FELLOWSHIPS FROM FOUNDATIONS AND INDUSTRIES**—At least 90 such fellowships, with various stipends, are awarded through the individual departments. Information and application forms may be secured from the head of the major department concerned. The fellowships which are awarded will vary somewhat from year to year, but the following are typical of those which were available for 1960-61:

**ALLIED CHEMICAL CORPORATION FELLOWSHIP**—Open to graduate students in chemistry; stipend \$2,500.

**AMERICAN CHEMICAL SOCIETY FELLOWSHIP (PETROLEUM RESEARCH FUND)**—Open to graduate students in ceramic technology; stipend \$2,280.

**AMERICAN CHEMICAL SOCIETY (PETROLEUM RESEARCH FUND)**—Open to graduate students in fuel technology; stipend \$2,220.

**AMERICAN CHEMICAL SOCIETY FELLOWSHIP (PETROLEUM RESEARCH FUND)**—Open to graduate students in chemistry and chemical engineering; stipend \$2,000-\$2,280.

**AMERICAN CYANAMID FELLOWSHIP IN CHEMISTRY AND CHEMICAL ENGINEERING**—Open to a graduate student for the final year of study leading to the Ph.D. degree. Awarded in alternate years to a chemist and to a chemical engineer; stipend \$1,800.

**AMERICAN IRON AND STEEL INSTITUTE (3)**—Open to graduate students in geochemistry and metallurgy; stipend \$2,400.

**AMERICAN PETROLEUM INSTITUTE FELLOWSHIPS (5)**—Open to graduate students in chemistry and physics for research concerning the synthesis and properties of high molecular weight hydrocarbons; stipend \$1,920-\$2,136.

**AMERICAN PETROLEUM INSTITUTE FELLOWSHIP**—Open to predoctoral and postdoctoral students in geochemistry, ceramic technology, or allied fields, for fundamental research concerning the synthesis and properties of clays and related inorganic phases; stipend \$3,600.

**BASIC, INC., FELLOWSHIP**—Open to graduate students in ceramic technology; stipend \$2,400.

**CARBORUNDUM CORPORATION FELLOWSHIP**—Available to a graduate student in mineral preparation; stipend \$2,040.

**CONTINENTAL OIL COMPANY FELLOWSHIP**—Available to graduate students in petroleum and natural gas engineering for studies in petroleum engineering; stipend \$2,280.

**CORNING GLASS WORKS FOUNDATION FELLOWSHIP**—In support of graduate work on glass or any of its components; stipend \$2,796.

**CURTISS-WRIGHT FELLOWSHIP**—Open to graduate students in engineering mechanics; stipend \$1,500.



## FELLOWSHIPS

DOW CORNING FELLOWSHIPS (4)—Open to graduate students in chemistry for fundamental studies in organosilicon compounds; stipend \$2,040.

EASTMAN KODAK FELLOWSHIP IN AERONAUTICAL ENGINEERING—Open to graduate students in the College of Engineering and Architecture; stipend \$1,000.

EASTMAN KODAK FELLOWSHIP—Open to advanced graduate students in physics for study leading to the Ph.D. degree; stipend \$2,500.

ESSO RESEARCH AND ENGINEERING POSTGRADUATE FELLOWSHIP IN CHEMISTRY AND CHEMICAL ENGINEERING—Open to advanced graduate students for one year of study leading to the Ph.D. degree; stipend \$1,800.

ETHYL CORPORATION FELLOWSHIP—Open to graduate students in chemistry; stipend \$1,900.

W. S. ELLIOTT FELLOWSHIP—Available to a graduate student who is a Penn State graduate and is interested in engineering research; stipend \$1,200.

GENERAL ATOMIC DIVISION OF GENERAL DYNAMICS CORPORATION FELLOWSHIP—Open to graduate students in physics; stipend \$2,500.

GENERAL ELECTRIC FELLOWSHIP—Open to graduate students in metallurgy; stipend \$2,880.

GENERAL FOODS FUND FELLOWSHIP (2)—For graduate work with a major in home economics; stipend \$3,000.

GULF OIL COMPANY FELLOWSHIP IN PETROLEUM AND NATURAL GAS ENGINEERING—For graduate work in petroleum production; stipend \$2,000.

HAMILTON STANDARD FELLOWSHIP—Open to graduates of this University in aeronautical engineering, electrical engineering, mechanical engineering, and engineering mechanics; stipend \$1800.

INTERNATIONAL BUSINESS MACHINES CORPORATION FELLOWSHIP—Open to an outstanding graduate student doing research in physical science or engineering. Fellowship is rotated annually among certain departments specified by the company; stipend \$1,800-\$2,500.

INTERNATIONAL MINERAL AND CHEMICAL CORPORATION FELLOWSHIP—Open to graduate students in mining engineering; stipend \$2,820.

KAISER ALUMINUM AND CHEMICAL CORPORATION FELLOWSHIP—Open to students in ceramic technology for studies in ceramic technology; stipend \$1,800.

KENNECOTT COPPER CORPORATION FELLOWSHIP—Open to graduate students in geophysics for studies relating to mining geophysics; stipend \$2,000.

KOPPERS, INC., FELLOWSHIPS (4)—Open to graduate students in chemistry; stipend \$2,000-\$2,280.

LEAD INDUSTRIES ASSOCIATION FELLOWSHIP—Open to graduate students in ceramic technology for studies of lead oxide systems; stipend \$1,992.

LEAD INDUSTRIES ASSOCIATION FELLOWSHIP—Open to graduate students in geochemistry; stipend \$2,400.

NATIONAL SCIENCE FOUNDATION CO-OPERATIVE GRADUATE FELLOWSHIPS (20 awarded)—The Graduate School participates in this program of fellowships available in the physical, biological, mathematical, engineering, and other sciences including anthropology, psychology (excluding clinical), geography, and certain selected social sciences. Applications for the following year must reach the Dean of the Graduate School by early November.

EDWARD ORTON, JR., CERAMIC FOUNDATION FELLOWSHIP—Open to students in ceramic technology for studies relating to kiln-fired ceramic bodies; stipend \$1,800.



OWENS-CORNING FIBERGLAS FELLOWSHIP IN INORGANIC CHEMISTRY—Open to a graduate student in inorganic chemistry for the final year of study leading to the Ph.D. degree; stipend \$2,400.

OWENS-CORNING FIBERGLAS FELLOWSHIP IN CERAMIC TECHNOLOGY—Open to graduate students in ceramic technology; stipend \$2,400.

PAN-AMERICAN FELLOWSHIP IN PETROLEUM AND NATURAL GAS ENGINEERING—Open to graduate students in petroleum and natural gas engineering for studies in petroleum production; stipend \$2,000.

PENNSYLVANIA CO-OPERATIVE WILDLIFE ASSOCIATION (2)—Available to graduate students in forestry; stipend \$1,872-\$2,016.

PENNSYLVANIA NATURAL GAS MEN'S FELLOWSHIP—For graduate work in petroleum and natural gas engineering for studies in gas technology; stipend \$2,000.

PITTSBURGH PLATE GLASS FELLOWSHIP—Open to graduate students in ceramic technology for fundamental studies of glass; stipend \$3,000.

RADIO CORPORATION OF AMERICA FELLOWSHIP—Open to graduate students in electrical engineering; stipend \$2,100.

SHELL FELLOWSHIP IN CHEMISTRY (2)—Open to graduate students in the Departments of Chemistry and Chemical Engineering for the final year of study leading to the Ph.D. degree; stipend \$1,800.

SOCONY-MOBIL OIL FELLOWSHIP—Available for graduate students in chemical engineering; stipend \$2,000.

SPEER CARBON FELLOWSHIP—Open to graduate students in fuel technology for studies on carbon; stipend \$2,400.

STACKPOLE FELLOWSHIP IN METALLURGY—Open to graduate students in metallurgy for studies in powder metallurgy; stipend \$2,280.

STAUFFER CHEMICAL COMPANY FELLOWSHIP IN CHEMISTRY—Open to a graduate student in chemistry for research on organo-metallic compounds; stipend \$1,800.

SUN OIL COMPANY FELLOWSHIP IN CHEMISTRY—Open to advanced graduate students in chemistry for study leading to the Ph.D. degree; stipend \$1,800.

TEXACO, INC., FELLOWSHIP—Open to a graduate student in physics; stipend \$3,000.

UNION CARBIDE METALS FELLOWSHIP—Open to graduate students in metallurgy; stipend \$2,280.

UNITED STATES DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE; OFFICE OF VOCATIONAL REHABILITATION TRAINEESHIPS IN VOCATIONAL REHABILITATION COUNSELING (36)—Open to graduate students in the Department of Educational Services who are specializing in vocational rehabilitation counseling; stipend \$1,800-\$2,000.

UNITED STATES PUBLIC HEALTH SERVICE TRAINEESHIPS IN CLINICAL PSYCHOLOGY (7) AND IN SCHOOL PSYCHOLOGY (3)—Open to selected graduate students in these areas of psychology; stipend \$2,000-\$3,000.

UNITED STATES STEEL FOUNDATION FELLOWSHIP—Open to graduate students in the College of Mineral Industries for studies related to steel-making; stipend \$2,500.

VETERANS ADMINISTRATION INTERNSHIPS IN CLINICAL PSYCHOLOGY (8)—Open to selected advanced graduate students in this area of psychology.

WEST PENN FLY ASH FELLOWSHIP—Open to graduate students in civil engineering; stipend \$2,000.

In addition, numerous grants are available from governmental agencies, industrial concerns, and foundations for the support of investigations of particular problems. Many of these permit full-time study and carry the same exemptions as the fellowships listed above. Detailed information may be secured from departments.

## OTHER STUDENT AIDS

Among these are the National Science Foundation Predoctoral Fellowships for graduate study in physical sciences, mathematics, biological sciences, earth sciences, psychology, anthropology, and areas where natural sciences converge with social sciences. These fellowships are used at the university of one's choice, and application should be made to the National Science Foundation, Washington 25, D. C.

**NATIONAL INSTITUTES OF HEALTH FELLOWSHIPS** (11 awarded)—Available to graduate students in the basic sciences, such as biology, chemistry, zoology, physiology, biochemistry, etc., as they relate to problems of health and disease; among the social sciences, those areas, such as psychology and sociology, which relate to the problems of health and disease and some interdisciplinary fields such as biostatistics, medical economics, cultural anthropology, etc. These fellowships are used at the university of one's choice, and application should be made to the Research Fellowship Review Branch, National Institutes of Health, Bethesda 14, Maryland.

**DU PONT POSTGRADUATE TEACHING ASSISTANTSHIP IN CHEMISTRY**—Open to a graduate student in chemistry who has had two years' experience as a graduate teaching assistant.

**JOHN W. WHITE FELLOWSHIPS**—Awarded to two graduates of The Pennsylvania State University each year on the basis of scholarship, need, character, and attitude. The recipients may enroll in any approved college or university.

**SCHOLARSHIPS**—A number of scholarships furnished by outside agencies and organizations are awarded annually through individual departments. A request for information should be directed to the department head in the field of the student's major interest.

**A.A.U.W. SCHOLARSHIP**—The State College Chapter of the American Association of University Women has established a modest scholarship which is awarded annually to honor an outstanding woman graduate student. The award does not include exemption from tuition. Nominations are made by departments.

**GRADUATE GRANTS-IN-AID**—Forty grants for full-time study are awarded each year, on a semester basis, providing for all tuition. They are available to any student on the basis of financial need and academic promise. A recipient is expected to carry a full program of graduate work, but may accept employment with the University or another employer not to exceed 10 hours per week, provided he reduces his academic load to 12 or 13 credits. Application for renewal of the grant-in-aid may be made for succeeding terms. The value of these grants to Pennsylvanians is \$240 per semester, to non-Pennsylvanians \$480 per semester (\$160 and \$320 per term).

Applications should be addressed to the Dean of the Graduate School and must be received by March 1 to be considered for the following summer or fall.

**GENERAL LOAN FUNDS**—Such funds are available from two sources: (1) University loan funds, in limited amounts; (2) loan funds received by the University under Title II of the National Defense Education Act of 1958. Graduate students who are classified as full-time students by the Dean of the Graduate School are eligible for a loan.

Information and application forms may be obtained from the director of the Office of Student Aid.

**GRADUATE SCHOOL EMERGENCY LOAN FUND**—This fund has been established through the efforts of the University Alumni Fund and contributions of Graduate School alumni who have received their bachelor's degrees elsewhere. The Graduate Student Association recently made a sizable contribution to it. The purpose of this fund is to assist graduate students on a short-term loan basis in meeting somewhat unexpected financial obligations associated with receiving a degree, such as thesis typing, thesis binding and microfilming fee, job interview travel, cap and gown rental, etc.



Loans may not exceed \$200. The fund is administered by the Dean of the Graduate School, and application forms may be obtained at his office.

**STUDENT EMPLOYMENT**—Many students depend upon part-time employment to help meet their expenses. A student who is thus employed, however, must recognize the time demands of his work schedule and will be required to adjust his academic load accordingly.

A student who holds a graduate assistantship or a fellowship may not accept employment, either at the University or elsewhere, during the period of his appointment. The Office of Student Aid, 112 Old Main, offers assistance to students in finding part-time employment in town as well as on the campus.

**VETERANS BENEFITS**—The Co-ordinator of Veterans Affairs has the responsibility of handling all applications for benefits under the various Public Laws.

Under Public Law 550, a student is classified as to his rate of training on the basis of the number of credits for which he registers and the type of program he is following.

**HEALTH CENTER**—The services of the Ritenour Health Center are available to graduate students registered for 12 or more credits and to all graduate assistants, fellows, and scholars.

Students are entitled to seven days' free treatment in the Hospital each semester. For each day of confinement in excess of one week a nominal charge of \$3 is made. Almost all modern drugs are furnished free of charge as required for treatment, but the student may be charged extra for medication where such treatment is unusual or extremely expensive. Consult the *Manual for Graduate Students* for details concerning facilities and services.

**INSURANCE PLAN**—A voluntary Accident and Sickness Insurance Plan with a variety of benefits is available to graduate students and their families. The Student Government Association, which operates the plan, has offices in the Hetzel Union Building.

**PLACEMENT SERVICE**—The University Placement Service co-ordinates the placement activities of all the Colleges and the Graduate School. It is available to any student who is in need of counseling or guidance on employment problems. The services of the following sections are available to the student without charge.

The General Placement Section functions primarily as a clearing house, bringing together students, alumni, faculty members, and representatives of organizations that are seeking college-trained personnel. Summer jobs other than those at camps or resorts are listed at this office.

The Teacher Placement Section assist seniors, alumni, and graduate students in all departments in securing teaching positions.

**RELIGIOUS PROGRAMS**—The University seeks to serve the spiritual needs of its students and staff. General responsibility for religious activity on the campus rests with the University Chaplain and Co-ordinator of Religious Affairs. Individual organizations under the sponsorship of members of the Jewish, Protestant, and Roman Catholic faiths serve the student body. Many other religious organizations, including denominational and interdenominational groups, are active on the campus and in association with local churches.

**STUDENT AFFAIRS**—The Graduate Student Association is the official University-wide organization of graduate students. All students enrolled during the academic year have membership in the Association, which promotes the general welfare and the academic interests of graduate students. It publishes the *Graduate School Newsletter*, maintains an up-to-date list of apartments for graduate students, helps to sponsor the Graduate School lecture series, and sponsors social functions.



## MASTERS' DEGREES

The Graduate School recognizes a difference in purpose, which is reflected in the requirements, for two types of advanced degrees: academic and professional. Of the eight masters' degrees conferred, the Master of Arts and the Master of Science are academic in nature. The professional degrees conferred are Master of Agriculture, Master of Business Administration, Master of Education, Master of Engineering, Master of Forestry, and Master of Public Administration.

The student should understand that a well-balanced, unified, and complete program of study will be required regardless of the minimum credit requirement. A degree is not conferred for a mere collection of credits. Many students find it necessary to earn more than the minimum number of credits before they are regarded as being ready for the degree. In order to avoid possible disappointment, the student should not think of the master's degree as a "one-year degree." The University is not committed to granting a degree upon completion of 30 credits.

The student may meet the degree requirements as either a full-time or a part-time student and by attendance either during the academic year or during the summer.

**ADMISSION**—Adequate undergraduate preparation is required in the field in which the applicant expects to pursue advanced work. The specific courses and the total number of undergraduate credits required in various areas will be determined by the choice of field and can be ascertained from the descriptive statement appearing under the major field heading in the latter portion of this bulletin. An applicant who meets the minimum grade point average but is deficient in course preparation may, under certain circumstances, be admitted to the Graduate School and allowed to make up the undergraduate deficiencies. Under these circumstances the program will require more than the minimum period of residence. An applicant for admission to the M.Ed. program is required to have had at least 18 credits in education and related psychology, and in certain major fields may be required to have had practice teaching.

After a student has been admitted as a regular graduate student, he should confer with the head of his major department concerning the appointment of an adviser. The general guidance of a master's candidate is the responsibility of an adviser, or of a committee appointed in a manner to be determined by the major department in which the student is specializing. The adviser or the committee assists the student in planning a program of study. Although the adviser is frequently the supervisor of the thesis, this is not necessarily the case.

Requirements concerning courses, language proficiency, minors, comprehensive examinations, and other matters are sometimes made by departments in addition to (but not in conflict with) the regulations of the Graduate School. For details the student should consult the head of the major department.

**TIME LIMITATION**—All requirements for a master's degree, whether satisfied here or elsewhere, must be met within six years, or a period spanning seven consecutive summers.

## M.A. AND M.S.—SPECIFIC REQUIREMENTS

The Master of Arts and the Master of Science degrees have similar requirements, the general major area determining which degree is conferred.

A minimum of 30 graduate credits is required of which at least 20 must be earned on the University Park Campus. A candidate must present a major and either a minor field of study or an approved group of general studies. A minor consists of no

fewer than 6 credits of integrated or articulated work in one field related to but different from that of the major. A general studies group consists of no fewer than 6 credits in fields other than that designated as the major field and considered by the major department to have significance and value for the candidate.

At least 18 credits in graduate courses (500 series) and thesis research (600 or 610) combined must be included in the program. A minimum of 12 credits in course work, as contrasted with research, must be completed in the major field and at least 6 credits must be devoted to a thesis.

The thesis is prepared under the direction of the department in which the candidate's major work is taken. Under certain conditions a student may complete the thesis off-campus. To do so he must make satisfactory arrangements in advance with both the major department and the Dean of the Graduate School.

A *Thesis Information Bulletin*, which gives details concerning format, paper, illustrations, and other items, may be obtained at the Graduate School office.

### M.AGR.—SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Agriculture has a professional orientation and provides training for increased competence in the various fields of agriculture. It should be clearly distinguished from the research-oriented program which leads to the academic degree of Master of Science.

A minimum of 30 graduate credits is required of which at least 20 must be earned on the University Park Campus.

A candidate is required to earn at least 12 credits in graduate courses (500 level) and a minimum of 12 credits outside his major field.

In addition to credit requirements, a candidate must present a paper on a selected professional problem comparable in quality to a thesis in which he applies scientific methods to the solution of a problem. Ability must be demonstrated to (a) formulate and state meaningfully the problem and objectives, (b) critically analyze the present state of knowledge of the problem, (c) acquire and analyze information to help solve the problem, (d) draw logical conclusions, and (e) interpret the relationship between findings and professional problems. The paper will be evaluated by a committee appointed by the Dean of the Graduate School.

The candidate is required to pass a final examination administered by a committee of three faculty members appointed by the Dean of the Graduate School with at least one member from a department other than that of the candidate's major field.

### M.B.A.—SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Business Administration is designed to develop advanced professional competence in the various fields of business administration. It should be distinguished carefully from the research-oriented programs which lead to the academic degree of Master of Science with a major in Business Administration and Doctor of Philosophy with a major in Business Administration.

The program requires a minimum of 36 graduate credits of which at least 18 must be at the 500 level and at least 26 must be earned on the University Park Campus. Candidates who enter this program without undergraduate training in business administration may be required to take up to 21 credits of preparatory courses.

Moreover, a candidate is required to present a project paper, comparable in quality and scope of work to a graduate thesis, concerning a problem of a company.



## MASTERS' DEGREES

After substantially completing his course requirements, a candidate must pass a comprehensive examination to be administered by a committee composed of graduate faculty members, the first part being written and the second part oral. During these examinations the candidate will be expected to demonstrate his ability to integrate the knowledge gained in the several functional areas of business in a manner which reflects a broad knowledge of his professional responsibilities.

Applicants for the various graduate programs in business administration are required to take the admission test for graduate study in business given by the Educational Testing Service.

### M.ED.—SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Education provides preparation for increased professional competence in the several fields of education. It should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Arts or Master of Science.

A minimum of 30 graduate credits is required of which at least 20 must be earned on the University Park Campus.

A minimum of 24 credits must be earned in course work. The larger part of this shall be in 500 series courses. The needs of the student shall be considered in arranging the best combination of 400 and 500 series courses for the preparation of the candidate in his particular field.

When the candidate chooses a group major, his program of study will be approved by a standing committee which will serve in the same relation to him as does a department in the case of a student with a specific major.

**MAJOR FIELDS**—A student may major in one of the fields of education, such as elementary education, art education, or home economics education, and in this case he will be required to earn at least 6 credits outside the fields of education. Such a program is under the guidance of the appropriate department of education.

However, a student who is preparing to teach in a specific subject-matter area, such as English, mathematics, or history, may choose such a field as his major and take the majority of his work in it under the guidance of that department. In this case the student is required to earn at least 6 credits in education. All candidates are required to take the examination in educational foundations which is administered by the Department of Educational Services. If adequate background is demonstrated, the candidate may then offer 6 credits in any field of education. If adequate background is not demonstrated, the 6 credits must be in educational foundations, which includes the following specific courses in comparative education, educational measurements and statistics, educational psychology, history of education, and philosophy of education: Ed.Ser. 417, 418, 490, 494, 516, 517, 522, 590; and Psy. 414, 502, 513, 514.

A student wishing to work in a broader field may choose a group major, such as social studies, physical science, or biological science. In this case, at least 24 credits are to be devoted to the group, and at least 6 to education. It is expected that each student will choose one subject of the group as a field of primary interest, to which at least 12 credits are to be devoted. All candidates are required to take the examination in educational foundations which is administered by the Department of Educational Services. If adequate background is demonstrated, the candidate may offer 6 credits in any field of education; if not, the 6 credits are restricted to educational foundations.

A candidate majoring in one of the fields of education is required to take a departmental diagnostic examination which serves as a guide in outlining a program of study that will fit his individual needs.



**THESIS OR TERM PAPER**—Six credits may be granted for an approved thesis. Those candidates who do not elect to write a thesis are required to present an essay or term paper. It must be of considerable proportion, indicating capacity to describe a serious intellectual experience adequately in writing, and giving unmistakable evidence of ability to formulate and state meaningfully the purpose of an investigation, study, critical analysis, or evaluation; to acquire and analyze information; to draw conclusions logically; and to relate findings to professional problems and practices. The nature and extent of such a piece of writing, whether it be required in connection with a course or independently of course work, and when it is to be undertaken shall be determined by the major department. The department shall report to the Dean of the Graduate School the title, the name of the faculty member under whom the student did the work, and whether the work was considered adequate. It is the right, but not the responsibility, of the department to require one or more copies of such an essay for its library or other files.

### M.ENG.—SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Engineering provides training for advanced professional competence in the several fields of engineering. It should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Science.

A minimum of 30 graduate credits is required of which at least 12 must be earned in graduate courses (500 series), and at least 6 must be earned outside the candidate's field of concentration.

A scholarly written report on a developmental study involving at least one area represented in the candidate's course work is required as an integral part of the program. The report must be comparable in its level of work and quality to a graduate thesis.

No work for this degree is required to be done specifically on the University Park Campus provided the major department or supervisory committee agrees that a suitable program can be pursued elsewhere.

### M.F.—SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Forestry provides training for increased professional competence in the several specialized areas of forestry and wood utilization. It should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Science with a major in forestry.

A minimum of 30 graduate credits is required of which at least 20 must be earned on the University Park Campus.

A candidate for the degree of Master of Forestry should choose one area for his major and one or two related areas for his minor. The proportion of credits to be taken in the major and minor fields of study will be determined in consultation with the student's advisory committee. It is expected that the larger part of the program shall be in graduate courses (500 series), but no specific number of credits in the 500 series is required.

Each candidate is required to prepare and submit an acceptable thesis. At least 6 credits of thesis work is required.

### M.P.A.—SPECIFIC REQUIREMENTS

The M.P.A. is a professional degree for students who are planning careers in public administration at local, state, national, and international levels or with private and voluntary agencies. This program should be distinguished carefully from the research-

## DOCTORAL DEGREES

oriented program which leads to the academic degree of Master of Arts with a major in Political Science in which the candidate may also specialize in public administration.

For the M.P.A. degree a minimum of 36 graduate credits is required of which at least 6 must be devoted to either a thesis or internship. Students with extensive government experience will write a thesis; others will serve an internship and write a critical review of the experience, the review to be comparable in quality to a thesis. A comprehensive final examination will be required of all students, the examination to be written, oral, or both.

No work for this degree is required to be done specifically on the University Park Campus provided the major department or supervising committee approves its being done elsewhere.

The degree is a terminal one and work taken toward it can not be applied automatically toward a doctorate.

## DOCTORAL DEGREES

The Doctor of Philosophy, an academic degree, and the Doctor of Education, a professional degree, are conferred. The two programs are recognized as different in purpose and consequently have different requirements in certain respects.

**ADMISSION**—A student who meets the general requirements for admission to the Graduate School and has been accepted by the department or committee in charge of a major field in which the doctorate is offered may begin working toward that degree. However, he has no official status as a doctoral student and no assurance that he will be accepted as a doctoral candidate until he has passed a candidacy examination. This examination is administered by the major department and is given near the end of the first, or at the beginning of the second, year of graduate work including that done for the master's degree and work done elsewhere as well as here (i.e., at about the time he has earned a total of 30 graduate credits).

A new student transferring from another graduate school with 30 or more transfer credits must take this examination before he has earned more than 10 credits here.

**GENERAL REQUIREMENTS**—No specified number of courses completed or credits earned will assure the attainment of the doctorate. The general requirements are based upon a period of residence, the passing of comprehensive examinations, and the writing of a satisfactory thesis. A doctoral program consists of such a combination of courses, seminars, and individual study and research as meets the minimum requirements of the Graduate School and is approved by the doctoral committee for each individual student. It includes work in a major field of study and in either a minor field or a group of general studies.

A master's degree is not a prerequisite for the doctorate. However, the first year of graduate study leading to the Ph.D. may be substantially the same as that provided for the M.A. or M.S. degree. Similarly the first year of the D.Ed. program may be essentially the same as that provided for the M.Ed.

**RESIDENCE REQUIREMENTS**—A minimum of three academic years of full-time graduate study and research, or their equivalent in credits, is required for a doctor's degree.

At least 30 credits must be earned in residence at the University Park Campus. For the Ph.D. degree a candidate must earn the minimum of 30 credits in residence in regular semesters, and for at least two semesters his work load must be limited to half-time at most, the balance of his time being devoted to graduate study. For the D.Ed. degree, the minimum residence requirement may be met by summer enrollment, although there is no guarantee that it will be possible to do so in all cases.



The Dean of the Graduate School is authorized to regard as a full-time student, for a period not exceeding one calendar year, a graduate assistant or research assistant who is a candidate for the doctorate, has passed the comprehensive examination, is registered for the maximum allowable credit load, and is certified by his department as devoting all his time to studies and thesis research to meet his degree requirements.

**OFF-CAMPUS AND TRANSFER CREDITS**—A maximum of two full academic years of residence work in another approved school granting the doctorate in the major field may be accepted by the Graduate School in partial fulfillment of the requirements for a doctoral degree at The Pennsylvania State University. Not more than one year of residence at a graduate school not granting the doctorate in the major field will be accepted here to apply toward doctoral degree requirements. Credit for courses and research work done elsewhere can be used to meet degree requirements, however, only if the work is appropriate to the candidate's proposed program of study as determined by his doctoral committee.

By securing the maximum allowable number of transfer credits, it is possible theoretically to complete the requirements at this institution in one academic year. In practice, however, this is rarely possible because of the sequence required in courses and examinations, special departmental requirements, and the possibility of protracted research. It must be remembered that the quality of the program rather than the time requirement is of paramount concern.

Subject to the approval of his adviser, the head of his major department, and the Dean of the Graduate School, a student may register for research to be done away from the University Park Campus. Such work will not be approved, however, simply because the arrangement is convenient for the student; scholarly considerations must determine the choice of location. A doctoral candidate may register for a maximum of 30 credits of research *in absentia*, but these credits must be included in the 60 credits (two academic years) which a candidate may earn in study away from the University Park Campus. The maximum load permitted a student who is employed full time is 6 credits in a semester and 5 credits distributed over the 12 weeks of the summer.

A candidate for a doctor's degree may apply toward the minimum requirements a maximum of 10 credits earned in approved classes in Continuing Education or at the Commonwealth Campuses of The Pennsylvania State University.

**ADVISERS AND DOCTORAL COMMITTEES**—After a student has been admitted as a regular graduate student, he should confer with the head of his major department concerning departmental procedures and the appointment of an adviser. The arrangement and approval of the details of the semester-by-semester schedule of the student is the function of the adviser. This person may be a member of the doctoral committee or someone else designated by the head of the major department for this specific duty.

The general guidance of a doctoral candidate is the responsibility of a doctoral committee consisting of five or more members of the Graduate Faculty. The committee is appointed by the Dean of the Graduate School, upon recommendation of the head of the major department, at the time the student is admitted to candidacy. The chairman of the committee must hold senior membership in the Graduate Faculty. The supervisor of the candidate's thesis will usually, but not necessarily, be designated as chairman. At his discretion, the Dean may add additional members to the committee.

The doctoral committee is responsible for establishing the broad outline of the student's program and should review the program as soon as possible after admission to candidacy. The committee will prepare, give, and evaluate the candidate's examinations, and supervise and approve his thesis. A favorable vote of at least two thirds of the members of the committee is required for passing a comprehensive or a final examination. If a candidate fails an examination, it is the responsibility of the doctoral committee to determine whether he may take another examination.



## DOCTORAL DEGREES

The committee will also notify the Dean when the candidate is ready to have his comprehensive and his final examination scheduled and will report the results of these examinations to the Dean.

**LANGUAGE EXAMINATIONS**—Candidates for the D.Ed. degree are not required to demonstrate a reading knowledge of a foreign language unless a special requirement is set up by the major department.

For the Ph.D. degree, the candidate is required to have a reading knowledge of at least two foreign languages. German and French are the languages most often needed. Other languages may be presented instead of these, if their choice is determined by scholarly and professional reasons. The choice of a language must be approved by the major department. If a language other than English, French, German, Italian, Russian, or Spanish is presented, it must be approved also by the Dean of the Graduate School. A student may not present his "mother tongue" as one of the two languages required in candidacy.

An important value of the foreign language training lies in the need to introduce the student to the non-English literature of a subject, and to make possible the use of this literature both during graduate training and during his subsequent professional career. The candidate for a degree therefore should prepare early in his graduate program to meet the foreign language requirements.

The language examinations are administered by the respective language departments of the University and are held three times each year, once during each semester and once during the summer. Specific dates may be obtained from the language department or from the calendar. So as to determine adequacy of preparation for the regular examination, every candidate is required to present himself to the language department concerned for a preliminary test in oral translation, not to exceed 15 minutes' duration, at the beginning of one of the terms.

Certificates of proficiency must be obtained if language requirements have been met at another institution prior to admission to the Graduate School at Penn State. In this case it is the general policy to require a letter from the Graduate Dean of the institution in which the foreign language examination was taken, stating that the examination taken by the student was that required of prospective Ph.D. candidates. Other evidence, such as examinations here, may also be required. (See the *Manual for Graduate Students* regarding the nature of the examination and registration therefor.)

**COMPREHENSIVE EXAMINATIONS**—A candidate for the Ph.D. or D.Ed. degree is required to take a comprehensive examination covering his major and minor fields to determine if he has adequate mastery of the subject matter to entitle him to proceed to the completion of a thesis.

This examination will normally be taken when the candidate has substantially completed his course work. In no case may the final examination be scheduled less than three months after the comprehensive examination. The comprehensive examination is to be given and evaluated by the doctoral committee and may be either written or oral, or both. A favorable vote of at least two thirds of the members of the committee is required for passing. In case of failure, it is the responsibility of the doctoral committee to determine if he may take another examination. The results are reported to the Dean of the Graduate School.

A candidate for the degree of Doctor of Philosophy must have satisfied the language requirements before taking the comprehensive examination.

**FINAL ORAL EXAMINATIONS**—The doctoral candidate who has satisfied all other requirements for the degree will be scheduled, on recommendation of the doctoral committee, to take a final examination. In no case may the final examination be scheduled less than three months after the comprehensive examination. The deadline for holding the examination is three weeks before Commencement.

The final examination is oral, open to the public, and related in large part to the thesis; but it may cover the whole field of study of the candidate without regard to courses that have been taken either here or elsewhere.

A favorable vote of at least two thirds of the members of the committee is required for passing. The results of the examination are reported to the Dean of the Graduate School and will be entered upon the candidate's official record. If a candidate fails, it is the responsibility of the doctoral committee to determine if he may take another examination.

## PH.D.—ADDITIONAL SPECIFIC REQUIREMENTS

Programs leading to the degree of Doctor of Philosophy are offered in a wide variety of fields. A program includes a major and either a minor or a group of general studies, with approximately two thirds of the total time being devoted to the major field. A minor consists of no fewer than 15 credits, including those applied toward the master's degree, of integrated or articulated work in one field related to, but different from, that of the major. A general studies group consists of no fewer than 15 credits, including those applied toward the master's degree, in fields other than that designated as the major field and considered by the major department to have significance and value for the candidate.

The degree is conferred in recognition of high attainment and productive scholarship in some special field of learning as evidenced by (1) the satisfactory completion of a prescribed period of study and investigation, (2) the preparation of a thesis involving independent research, and (3) the successful passing of examinations covering both the special subject and the general field of learning of which this subject forms a part.

**THESIS**—The ability to do independent research and competence in scholarly exposition must be demonstrated by the preparation of a thesis on some topic related to the major subject. It should represent a significant contribution to knowledge, be presented in a scholarly manner, reveal on the part of the candidate an ability to do independent research of high quality, and indicate considerable experience in using a variety of research techniques. The contents and conclusions of the thesis must be defended at the time of the final examination.

The completed thesis together with an abstract, typewritten in triplicate, must be filed in the office of the Dean of the Graduate School not later than two weeks prior to the commencement at which the candidate expects to receive the degree.

A *Thesis Information Bulletin*, which gives details concerning format, paper, illustrations, and other items, may be obtained at the Graduate School office.

## D.ED.—ADDITIONAL SPECIFIC REQUIREMENTS

Programs leading to the degree of Doctor of Education are not limited to specific fields of education but, with the consent of the department or committee in charge, may also be offered in any other field appropriate to the preparation of teachers which has been approved for the doctorate, such as biological science, chemistry, or English.

The degree is conferred in recognition of advanced preparation of a high order for work in the profession of education as evidenced by (1) the satisfactory completion of a prescribed period of study; (2) ability to apply scientific principles in classroom instruction, supervision of instruction, administration, or as a consulting specialist in certain educational areas; (3) preparation of a thesis demonstrating ability to undertake an educational problem with originality and independent thought; and (4) successfully passing examinations showing a satisfactory grasp of the field of specialization and its relation to allied educational areas.



## DOCTORAL DEGREES

Every candidate must show, through comprehensive examinations, that he is familiar with current theories of education; that he understands and can apply the techniques and the findings of educational research so far as they bear upon the teaching of his subject; that he is prepared to read understandingly and contribute to the technical and professional literature in his field; and that he can criticize his own procedures in the light of historical trends and practices in this and other countries. Command of the tools for a thorough study of the problems of education is necessary and must include familiarity with statistical methods. For certain students the requirements may include a reading knowledge of one or more foreign languages.

**MAJOR AND MINOR FIELDS**—The program of study includes a major and either a minor or a group of general studies. A majority of the courses offered in fulfillment of the requirements must be in the major field of study.

A candidate choosing a major outside the fields of education (such as chemistry, English, or history) shall have a minor consisting of no fewer than 15 credits, including those applied toward the master's degree, in educational foundations, which includes the following specific courses in comparative education, educational measurements and statistics, educational psychology, history of education, and philosophy of education: Ed.Ser. 417, 418, 490, 494, 516, 517, 522, 590; and Psy. 414, 502, 513, 514.

A candidate choosing a major in one of the fields of education must also choose either a minor or a group of general studies with the approval of the major department. In this case a minor consists of no fewer than 15 credits, including those applied toward the master's degree, in one field outside the fields of education. An acceptable general studies group consists of no fewer than 15 credits, including those applied toward the master's degree, in fields outside the fields of education considered by the major department to have significance and value for the candidate.

**THESIS**—Evidence of a high degree of scholarship, competence in scholarly exposition, and ability to select, organize, and apply knowledge must be presented by the candidate in the form of a written thesis. The candidate must demonstrate a capacity for independent thought as well as ability and originality in the application of educational principles or in the development of new generalizations under scientific controls. The thesis may be based upon a product or project of a professional nature, provided that scholarly research is involved. For example, it may be based upon the solution of a professional problem concerned with the development of a curriculum, or a product of creative effort related to education. However, in order to be acceptable as a thesis, the professional project must be accompanied by a written discourse demonstrating the nature of the research and including such theories, experiments, and other rational processes as were used in effecting the final result. The topic and outline of the proposed thesis must have the approval of the doctoral committee.

The completed thesis together with an abstract, typewritten in triplicate, must be filed in the office of the Dean of the Graduate School not later than two weeks prior to the commencement at which the candidate expects to receive the degree.

A *Thesis Information Bulletin*, which gives details concerning format, paper, illustrations, and other items, may be obtained at the Graduate School office.



# PROGRAMS AND COURSES

Programs of study leading to advanced degrees are offered in many major and minor fields. These are listed in the following section, and the major fields are summarized on page 50. Related courses are grouped together under the name of the field. To locate a particular course or group of courses consult the index.

In general, departments of the University are identified with specific major fields. Thus aeronautical engineering is a major field of study which is offered under the supervision of the Department of Aeronautical Engineering. On the other hand, biological science and comparative literature are major fields for which there are no corresponding departments. In such cases a committee of the Graduate School is responsible for administering the program. In some cases a single department offers work in more than one field. Thus the Department of Civil Engineering offers work in both civil and sanitary engineering.

Applicants for admission are encouraged to consult the person whose name is listed under the major field heading.

**DEGREES**—In those major fields approved for the doctorate the Ph.D. is normally conferred, although a program leading to the D.Ed. may also be arranged with the consent of the department or committee in charge if such a professional program is appropriate. Similarly in major fields approved for the master's degree the M.A. or M.S. is normally conferred, but a program leading to the M.Agr., M.B.A., M.Ed., M.Eng., or M.P.A. may also be available. The D.Ed. and M.Ed. are not limited to the fields of education, but with the consent of the department or committee in charge may be offered in any approved major field appropriate to the preparation of teachers, such as chemistry or English. In this case the program is sponsored by a major department outside the fields of education, such as the Department of Chemistry, but the student's minor is in education.

**MINOR FIELDS**—All major fields listed are also acceptable as minors. In addition, a few fields in which no advanced degrees are offered have been approved as minors for candidates who are majoring in related areas. Such minor fields are identified by a brief statement under the field heading.

A candidate's choice of minor field depends upon the particular degree he is seeking and is subject to the approval of his major department. The requirements in each minor field are established by the minor department subject to the regulations of the Graduate Faculty.

**INTERDISCIPLINARY MAJORS**—In addition to the majors listed on page 50, interdisciplinary majors involving two or more departments may be arranged with the approval of the Dean of the Graduate School. These programs are offered under the supervision of appropriate interdepartmental committees.

**OTHER FIELDS**—Fields which have not been approved for either major or minor work, but in which approved courses are offered, are listed in Part II of this bulletin. These courses may be used in graduate programs as electives or as part of a general studies program, subject to the approval of the major department and to the restrictions upon the use of 400 series courses in degree programs.

**COURSE NUMBERING SYSTEM**—Courses in the series 1-399 are not listed in this bulletin because they are strictly undergraduate courses and yield no graduate credit. A graduate student may register for or audit these courses in order to make up deficiencies or fill in gaps in his earlier education but not to meet requirements for an advanced degree.

## PROGRAMS AND COURSES

Courses in the series 400-499 are for upperclassmen with at least junior standing and for graduate students. Only a limited number of credits earned in these courses may be counted toward the requirements for an advanced degree. Detailed regulations are given in the preceding section of this bulletin.

Courses in the series 500-599 are restricted to students registered in the Graduate School, seniors with an average of at least 3.5, and other students who have been granted permission to enroll by the Dean of the Graduate School.

Course numbers 600 and 610 apply to thesis research and are available only to students registered in the Graduate School.

**COURSE DESCRIPTIONS**—A course abbreviation, a number, and a title designate each course. Course designations and official abbreviations are listed at the left-hand margin just above the first course in each group. The figures in parentheses following the course title show the number of credits which may be granted for that course. In the case of courses with variable credits, the number of credits which may be earned in a single semester or session is determined by the department offering the course.

A department may schedule an entire section of a course below the 400 level for fewer credits than the maximum authorized. In 400 and 500 series courses a department may schedule an individual student for fewer credits than the maximum number but in no case for more than the maximum number authorized.

**SCHEDULE OF COURSES**—Not all courses are given each term. A complete list of the courses which will be offered in any specific term is given in the *Timetable*, which is available at nominal cost from the Registrar's Office a few weeks before the beginning of each session. The *Timetable* gives the number of credits being offered in each course, the hours at which the class will meet, the location of the class, and in some cases the instructor's name.

The list of courses given in the *Timetable* is subject to modification at registration time. The number enrolling in a course, the availability of staff members, and other circumstances may result in the cancellation of some courses and the offering of others. Decisions are made by the departments offering the courses.

**RESEARCH AND THESIS WORK**—In general, students registering for work on a master's or a doctor's thesis will, if it is to be done on the University Park Campus, use course number 600 preceded by an abbreviation designating the major field. Thus Aro.E. 600 signifies thesis research in aeronautical engineering. In case such work has been authorized for students not working on the University Park Campus, the number 610 will be used. Credits will be 1 to 15 per semester.

It should be assumed that the numbers 600 and 610 are available in all fields in which majors have been approved for advanced degrees although these numbers do not appear in the timetables.

MAJOR  
and  
MINOR  
FIELDS



## GRADUATE FIELDS OF STUDY

Aeronautical Engineering, Ph.D., M.S., M.Eng.	History, Ph.D., D.Ed., M.A., M.Ed.
Agricultural and Biological Chemistry, Ph.D., M.S.	Home Art (minor only)
Agricultural Economics, Ph.D., M.S.	Home Economics Education, Ph.D., D.Ed., M.S., M.Ed.
Agricultural Education, Ph.D., D.Ed., M.S., M.Ed.	Home Economics, General, Ph.D., D.Ed., M.S., M.Ed.
Agricultural Engineering, M.S.	Home Management and Family Economics, Ph.D., D.Ed., M.S., M.Ed.
Agronomy, Ph.D., M.S., M.Agr.	Horticulture, Ph.D., M.S.
Animal Husbandry, Ph.D., M.S.	Industrial Arts Education, Ph.D., D.Ed., M.S., M.Ed.
Animal Nutrition, Ph.D., M.S.	Industrial Engineering, M.S., M.Eng.
Architectural Engineering, M.S.	Institution Administration, M.S.
Architecture, M.S.	Journalism, M.A.
Art, M.A.	Mathematics, Ph.D., D.Ed., M.A., M.Ed.
Art Education, Ph.D., D.Ed. M.S., M.Ed.	Mechanical Engineering, Ph.D., M.S., M.Eng.
Bacteriology, Ph.D., M.S.	Metallurgy, Ph.D., M.S.
Biological Science, D.Ed., M.Ed.	Meteorology, Ph.D., M.S.
Botany, Ph.D., M.S.	Mineral Economics, Ph.D., M.S.
Business Administration, Ph.D., M.S., M.B.A.	Mineral Preparation, Ph.D., M.S.
Business Education, Ph.D., D.Ed., M.S., M.Ed.	Mineralogy and Petrology, Ph.D., M.S.
Ceramic Technology, Ph.D., M.S.	Mining Engineering, Ph.D., M.S.
Chemical Engineering, Ph.D., M.S.	Music, M.A.
Chemistry, Ph.D., D.Ed., M.S., M.Ed.	Music Education, D.Ed., M.Ed.
Child Development, Ph.D., D.Ed.	Nuclear Engineering, M.S., M.Eng.
Child Development and Family Relationships, M.S., M.Ed.	Nutrition in Public Health, M.S.
Civil Engineering, Ph.D., M.S., M.Eng.	Petroleum and Natural Gas Engineering, Ph.D., M.S.
Clinical Speech, Ph.D., D.Ed., M.S., M.Ed.	Philosophy, Ph.D., M.A.
Clothing and Textiles, Ph.D., D.Ed., M.S., M.Ed.	Physical Education, Ph.D., D.Ed., M.S., M.Ed.
Comparative Literature, Ph.D., M.A.	Physical Science, D.Ed., M.Ed.
Counseling in Education, Ph.D., D.Ed., M.S., M.Ed.	Physics, Ph.D., M.S.
Dairy Science, Ph.D., M.S.	Plant Pathology, Ph.D., M.S.
Economics, Ph.D., M.A.	Political Science, Ph.D., M.A., M.P.A.
Educational Administration, Ph.D., D.Ed., M.S., M.Ed.	Poultry Husbandry, Ph.D., M.S.
Electrical Engineering, Ph.D., M.S., M.Eng.	Psychology, Ph.D., D.Ed., M.S., M.Ed.
Elementary Education, Ph.D., D.Ed., M.S., M.Ed.	Public Administration, M.P.A.
Engineering Mechanics, Ph.D., M.S., M.Eng.	Recreation Education, Ph.D., D.Ed., M.S., M.Ed.
English, Ph.D., D.Ed., M.A., M.Ed.	Romance Languages and Literatures, Ph.D., M.A.
Entomology, Ph.D., M.S.	Rural Sociology, Ph.D., M.S.
Family Relationships, Ph.D., D.Ed.	Sanitary Engineering, M.S., M.Eng.
Foods and Nutrition, Ph.D., D.Ed., M.S., M.Ed.	Secondary Education, Ph.D., D.Ed., M.S., M.Ed.
Forestry, M.S., M.F.	Social Studies, M.Ed.
Fuel Technology, Ph.D., M.S.	Sociology, Ph.D., M.A.
Genetics and Breeding, Ph.D., M.S.	Speech, Ph.D., D.Ed., M.A., M.Ed.
Geochemistry, Ph.D., M.S.	Statistics (minor only)
Geography, Ph.D., D.Ed., M.S., M.Ed.	Theatre Arts, M.A.
Geology, Ph.D., M.S.	Vocational Industrial Education, Ph.D., D.Ed., M.S., M.Ed.
Geophysics, Ph.D., M.S.	Wildlife Management, M.S.
German, Ph.D., M.A., M.Ed.	Zoology, Ph.D., M.S.
Higher Education, D.Ed.	

The degrees listed above are the ones normally conferred in each of the designated major fields. Additional professional degrees, including the M.Agr., M.Ed., and M.Eng., have been authorized in many cases and may be offered at the discretion of the department head and the Dean of the Graduate School. Thus, the M.Ed. has been authorized for all of the above fields in which a master's degree is conferred provided the field is appropriate to the preparation of teachers.

## Part I

### *Courses in Major and Minor Fields*

## AERONAUTICAL ENGINEERING

JOHN A. Fox, *Acting Head of the Department*  
203 Engineering D

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Professor Wislicenus; Associate Professor Fox; Assistant Professor Li.

Course work and research are available in the following areas: classical and modern hydro-, aero-, and gas-dynamics, including aerochemistry and magneto-hydrodynamics; structures; aeroelasticity; turbo-machinery, advanced propulsion; low-speed flight.

The entering student must hold a bachelor's degree in science, mathematics, or engineering and must have completed undergraduate course work in fluid and solid mechanics and in intermediate mathematical analysis.

### AERONAUTICAL ENGINEERING (ARO E)

401a,b,c. AERONAUTICAL ENGINEERING PROJECTS (2-12)

402. PROPULSION SYSTEMS DESIGN (3)

403. APPLIED AERODYNAMICS (3)

404. AIRPLANE AND MISSILE DESIGN (3)

407. DYNAMICS OF LOW-SPEED FLIGHT (3)

408. AERONAUTICAL AND ASTRONAUTICAL TURBOMACHINERY (3)

409. ADVANCED AIRCRAFT STRUCTURES (3)

410. AIRCRAFT AND SPACE PROPULSION (3)

411. AEROELASTICITY (3)

412. THEORETICAL AERODYNAMICS (3)

413. AERONAUTICAL DYNAMICS (3)

414. GASDYNAMICS (3)

415. ADVANCED THEORETICAL FLUID DYNAMICS (3-6)

416-417. AERO-SPACE SEMINAR (1 each)

501. AIRPLANE STABILITY AND CONTROL (3) General analysis of longitudinal and lateral stability of airplanes; characteristics of flight control devices. Prerequisite: Aro.E. 403.

503. AIRPLANE PERFORMANCE (3) Methods of performance prediction and performance flight testing for high-speed aircraft and missiles. Prerequisite: Aro.E. 403.

504. ROTARY WING AIRCRAFT (3) Types of rotary wing aircraft; helicopter performance, stability, and control; structural and vibration problems. Prerequisites: Aro.E. 403, 409.

505. AEROELASTICITY (3) Vibrating systems with several degrees of freedom; analysis of flutter speed of an airplane wing considering bending, torsion, and aileron motions; other types of aircraft flutter. Prerequisites: Aro.E. 412; E.Mch. 401 or Aro.E. 411.

## AERONAUTICAL ENGINEERING

506. AIRCRAFT STRUCTURES (3-9) Deflections of beams and trusses; statically indeterminate structures; shear-flow analysis and shearing deformations of multi-cell semi-monocoque structures; effects of discontinuities in wing and fuselage structures. Prerequisites: Aro.E. 409, E.Mch. 408.
507. AIRCRAFT GAS TURBINES AND JET PROPULSION ENGINES (3) Types of jet propulsion installations, thermodynamic cycles, analysis of compressors, combustion chambers, and turbines. Prerequisite: Aro.E. 410.
510. AERODYNAMICS OF COMPRESSIBLE FLUIDS (3) One-dimensional motion, shock waves, flow in nozzles, two-dimensional flow, airfoil theory, Prandtl-Meyer flow, method of characteristics. Prerequisite: Aro.E. 412.
511. AERODYNAMICS OF A PERFECT FLUID (3) Euler's dynamic equations, complex potential, conformal transformation, thin airfoils, Biot-Savart law; Prandtl three-dimensional airfoil theory. Prerequisite: Aro.E. 412.
512. AERODYNAMICS OF A VISCOUS FLUID (3) Navier-Stokes equations, incompressible and compressible boundary layer theory, jet and wake problems, hydrodynamic stability, turbulence. Prerequisite: Aro.E. 412.
513. RESEARCH IN AERONAUTICAL ENGINEERING (1-15 per semester) Investigation of a theoretical or experimental project in aeronautical engineering.
514. AERONAUTICAL ENGINEERING SEMINAR (1 per semester) Current literature and special problems in aeronautical engineering.
515. AERODYNAMICS (3) Airflow, airplane performance. For students with undergraduate training in science or engineering curriculums other than aeronautical engineering.
516. SPECIAL TOPICS IN AIRCRAFT STRUCTURES (3-9)
519. FLUID DYNAMICS OF ROTATING MACHINERY (3-6) Prerequisite: Aro.E. 412.
520. SPECIAL TOPICS IN AERODYNAMICS (3-9)

## AGRICULTURAL AND BIOLOGICAL CHEMISTRY

HOWARD O. TRIEBOLD, *Head of the Department*  
109 Frear Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Althouse, Benson, Boucher, Clagett, Frear, Guerrant, Mallette, Pritham, Sullivan, and Triebold; Associate Professor Shigley.

Opportunities for research and graduate study are available in plant metabolism and photosynthesis, intermediary metabolism, nucleic acids, proteins, carbohydrates, lipides, enzymes, vitamins, animal nutrition, poultry nutrition, clinical chemistry, endocrinology, and pesticides.

Entering graduate students should have had at least one year's work in each of the following: general chemistry, analytical chemistry, organic chemistry, physical chemistry, and general physics. Mathematics through integral calculus is also required. Students with limited deficiencies in these subjects may be admitted but must make up such deficiencies concurrently with their graduate studies. Undergraduate courses in biology, biochemistry, and foreign languages will be helpful to the student but are not required for admission.



# AGRICULTURAL AND BIOLOGICAL CHEMISTRY

## AGRICULTURAL AND BIOLOGICAL CHEMISTRY (AB CH)

- |                                                     |                              |
|-----------------------------------------------------|------------------------------|
| 401. GENERAL BIOCHEMISTRY (4)                       | Mr. Clagett                  |
| 402. GENERAL BIOCHEMISTRY (4)                       | Mr. Clagett                  |
| 403. DAIRY CHEMISTRY (3)                            | Mr. Shigley                  |
| 404. FOOD CHEMISTRY (4)                             | Mr. Triebold                 |
| 413. PRINCIPLES OF ANIMAL NUTRITION (3)             |                              |
| 417. METHODS OF AGRICULTURAL ANALYSIS (4)           | Messrs. Triebold and Clagett |
| 425. BIOPHYSICAL CHEMISTRY (4)                      | Mr. Mallette                 |
| 426. BIOCOLLOIDS (3)                                | Mr. Mallette                 |
| 437. PHYSIOLOGICAL CHEMISTRY (5)                    | Mr. Pritham                  |
| 438. PHYSIOLOGICAL CHEMISTRY (CLINICAL METHODS) (5) | Mr. Pritham                  |
| 439. PROBLEMS IN AGRICULTURAL CHEMISTRY (3-5)       |                              |
| 440. PLANT BIOCHEMISTRY (3)                         | Mr. Clagett                  |
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501. ENZYMES (2) Investigations and theories concerning nature of enzymes, enzyme action, influence of chemical environment on enzyme action, and biological applications. Prerequisite: A.B.Ch. 437. Fall semester. Mr. Clagett
503. BIOCHEMICAL PROBLEMS (1-10 per semester) Prosecution of an assigned problem under the guidance of an instructor.
505. VITAMINS AND DIETARY DEFICIENCY DISEASES (2) Lectures, conferences, and assigned reading. Prerequisite: A.B.Ch. 437. Fall semester, odd years. Mr. Guerrant
506. VITAMIN ASSAY METHODS (2) Lectures, conferences, and demonstrations dealing with approved methods of vitamin assay including demonstrations of typical vitamin deficiency syndromes in the rat. Prerequisite: A.B.Ch. 505. Spring semester, even years. Mr. Guerrant
- 507a. SEMINAR IN PHYSIOLOGICAL CHEMISTRY AND NUTRITION (1 per semester) Messrs. Guerrant, Boucher, and Pritham
- 507b. SEMINAR IN FOODS AND ANALYTICAL CHEMISTRY (1 per semester) Fall semester. Messrs. Triebold and Shigley
- 507c. SEMINAR IN PLANT, ENZYME, AND INSECTICIDE CHEMISTRY (1 per semester) Spring semester. Messrs. Frear, Benson, Mallette, and Clagett
508. BIOCHEMICAL LITERATURE (1-3) Assigned readings, reports, and conferences on selected topics in biochemistry. Prerequisite: A.B.Ch. 437.
510. PROTEINS, AMINO ACIDS, AND PEPTIDES (2) Organic, physical, and biological chemistry of the naturally occurring compounds of this group. Prerequisites: A.B.Ch. 425, 437. Fall semester. Mr. Mallette
511. CARBOHYDRATES (2) Chemical constitution and properties of carbohydrates; their metabolism in plant and animal organisms. Prerequisite: A.B.Ch. 437. Spring semester. Mr. Benson
512. LIPIDES (2) Investigations on biochemistry of fats and related substances. Spring semester. Mr. Shigley
515. BIOMETRY (2) Application of statistical methods to research problems in biochemistry and biology. Prerequisite: Ag. 400. Spring semester, odd years.
516. CHEMISTRY OF THE PESTICIDES (2) Lectures and assigned readings on the chemistry of insecticides, fungicides, herbicides, rodenticides, and related materials. Prerequisite: Chem. 31 or A.B.Ch. 437. Fall semester, even years. Mr. Frear

## AGRICULTURAL AND BIOLOGICAL CHEMISTRY

517. ENDOCRINE SECRETIONS (2) Chemistry of hormones and their physiological significance. Prerequisite: A.B.Ch. 437. Spring semester, even years.  
*Mr. Pritham*
518. MINERAL METABOLISM (2) Utilization and function of mineral elements in animal nutrition. Prerequisite: A.B.Ch. 437. Spring semester, odd years.  
*Mr. Boucher*
519. INTERMEDIARY METABOLISM (3) Processes involved in the utilization of metabolites in plants and animals. Prerequisite: A.B.Ch. 402.  
*Mr. Mallette*
520. BIOCHEMICAL METHODS (3) Lectures and advanced laboratory on current techniques pertaining particularly to research on proteins and enzymes. Prerequisite or concurrent: A.B.Ch. 501, 510.  
*Messrs. Clagett and Mallette*
521. BIOCHEMICAL METHODS (3) Lectures and advanced laboratory on current techniques pertaining particularly to research on lipides and carbohydrates. Prerequisite or concurrent: A.B.Ch. 511, 512.  
*Messrs. Benson and Shigley*

## AGRICULTURAL ECONOMICS

MACKLIN E. JOHN

*Head of the Department of Agricultural Economics and Rural Sociology*

1 Weaver Building

*Degrees Conferred: Ph.D., M.S.*

*Graduate Faculty: Professors Baker, Barr, Becker, Brandow, Butz, Frey, Hutton, Pasto, Pierce, and Southworth; Associate Professors McAlexander and Trotter.*

The entering student in the master's program should have as prerequisites 3 credits in agricultural economics, 3 credits in economics, and 3 additional credits in either agricultural economics or economics. If a student lacks some of the prerequisites, he may take them without graduate credit during the early part of his master's program.

### AGRICULTURAL ECONOMICS (AG EC)

407. ADVANCED FARM MANAGEMENT (3) *Mr. Hutton*
420. AGRICULTURAL PRICES (3) *Mr. Brandow*
421. LAND ECONOMICS (3) *Mr. Frey*
426. (A.H. 426). LIVESTOCK MARKETING (3) *Mr. Trotter*
500. SEMINAR IN AGRICULTURAL ECONOMICS (1-6) Review of current literature and problems.
503. RESEARCH METHODS IN FARM MANAGEMENT (1-3) Evaluation of research procedures, methods, results, and needs in the field; emphasis on their application to specific research problems. Prerequisites: Ag.Ec. 6, Econ. 14.
504. AGRICULTURAL PRICE AND INCOME POLICY (3) Analysis of farm prices, income consequences for producers and consumers, and effects on resource use; evaluation of policy, considerations in policy making. Prerequisites: Ag.Ec. 420, Econ. 405.  
*Mr. Brandow*
505. ADVANCED AGRICULTURAL STATISTICS (3) Multiple correlation, curve fitting, analysis of variance, selection of samples, and other techniques applicable to the rural social sciences. Prerequisite: 3 credits in statistics.  
*Mr. Bennett*



## AGRICULTURAL ECONOMICS

506. ECONOMIC PROBLEMS IN MARKETING SPECIFIC AGRICULTURAL PRODUCTS (3) Profit maximization; psychological and sociological aspects of selling; engineering aspects of cost reduction; techniques in developing information for managerial decisions.
507. SEMINAR IN FARM MANAGEMENT (1-6) Special problems relating to organization and operation of the farm business. Prerequisites: Ag.Ec. 6, Econ. 14.
510. ADVANCED FARM FINANCE (1-3) Problems and policies in agricultural credit, insurance, and farm financial management. *Mr. Hutton*
515. ECONOMIC PROBLEMS IN THE MARKETING OF DAIRY PRODUCTS (3) Economic problems as they are encountered in the process of marketing; particular attention to governmental regulation in pricing and marketing. *Mr. Pierce*
517. PROBLEMS AND POLICIES OF FARMER CO-OPERATIVES (3) Specific types of co-operative organizations, their problems, policies, and progress; relationships existing among co-operatives, between co-operatives and other business organizations, and between co-operatives and the public. Prerequisite: Ag.Ec. 17. *Mr. Becker*
520. FARM PRICE ANALYSIS (3) Econometric analysis of prices, production, and utilization of farm products; review of research in this field. Prerequisites: Ag.Ec. 420, 505; Econ. 405. *Mr. Brandow*
522. ADVANCED FARM APPRAISAL (3) Land value theory; methods of land valuation; field practice in farm appraisal. *Mr. Frey*
525. RESEARCH METHODS IN RURAL SOCIAL SCIENCES (2) Scientific method in planning and conducting research. Prerequisite: 9 credits in social sciences. *Mr. John*
526. RESEARCH METHODS IN AGRICULTURAL ECONOMICS (2) Application of economic and statistical principles. *Mr. Baker*
534. AGRICULTURAL PRODUCTION ECONOMICS (3) Economic theory applied to agricultural production problems: resource combination, firm size, uncertainty and expectations, aggregate aspects of production, technological change. *Mr. McAlexander*
535. SEMINAR IN AGRICULTURAL MARKETING (2) *Mr. Southworth*
536. SEMINAR IN DAIRY ECONOMICS (1 per semester) *Messrs. Pierce and Butz*

## AGRICULTURAL EDUCATION

DAVID R. McCLAY, *Head of the Department*  
101 Agricultural Education Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors McClay and Stevens; Assistant Professor Hoover.

The requirements for admission to graduate work in agricultural education are 18 semester hours in professional education courses including educational psychology and practice teaching in vocational agriculture, or certification to teach vocational agriculture. Students who lack any part of these requirements may be admitted but are required to fulfill deficiencies without degree credit.

Minors may be taken in any of the areas of agricultural technology, or, for Master



## AGRICULTURAL EDUCATION

of Science and Doctor of Philosophy degree candidates, in one of the other fields of education, such as educational administration or higher education.

### AGRICULTURAL EDUCATION (AG ED)

- 418v. SURVEY OF VOCATIONAL EDUCATION IN AGRICULTURE (1-3) *Mr. Hoover*  
420v. ADVANCED VISUAL AND OTHER SENSORY AIDS IN TEACHING AGRICULTURE (1-6) *Mr. Anthony*  
422v. SUPERVISION OF VOCATIONAL EDUCATION IN AGRICULTURE (1-3) *Mr. Anthony*  
426v. YOUNG AND ADULT FARMER EDUCATION IN VOCATIONAL AGRICULTURE (1-4)  
434v. AGRICULTURAL DEVELOPMENTS (1-6) *Mr. Hoover*  
501v. HISTORY OF AGRICULTURAL EDUCATION (1-3) Development of training for agricultural vocations; emphasis upon introduction of agricultural instruction into the high school program. *Mr. Hoover*  
502v. TEACHING VOCATIONAL AGRICULTURE (1-3) Organization of instruction with respect to vocational objectives, methods of presentation, supervision of practice, pupil evaluation of goals, and follow-up. *Mr. Stevens*  
503v. RESEARCH IN AGRICULTURAL EDUCATION (1-6 per semester) Individual study problems in various phases of agricultural education, such as evaluation of teaching, teaching procedures, and teacher preparation. *Mr. Stevens*  
504v. AGRICULTURAL EDUCATION SEMINAR (1 per semester) *Mr. McClay and Staff*  
508v. STATE AND COUNTY ADMINISTRATION AND SUPERVISION OF AGRICULTURAL EDUCATION (1-3) Organization and administration of state, county, township, and district systems of agricultural education; state and federal legislation. *Mr. McClay*  
509v. TEACHER TRAINING IN AGRICULTURAL EDUCATION (1-6) Construction of college curriculums, courses of study, and organization of college departments for training agricultural teachers. *Mr. McClay*  
520v. SCIENTIFIC METHOD IN THE STUDY OF AGRICULTURAL EDUCATION (1-4) Methods of procedure in investigation and experimentation in education, accompanied by a critical examination of studies made in agricultural education. *Mr. Stevens*  
521v. SCIENTIFIC METHOD IN THE STUDY OF AGRICULTURAL EDUCATION (1-4) Continuation of Ag.Ed. 520v; emphasis upon statistical techniques for students' individual problems. *Mr. Stevens*  
524v. ANNUAL PLAN OF WORK (1-3) Detailed study of the agricultural education needs of each student's community and outlining annual plans of work. *Mr. Hoover*  
530. AGRICULTURAL COLLEGE TEACHING (3) Selection and organization of subject matter for specific courses, methods of learning, teaching devices, technique of teaching, and measurements of results of teaching. *Mr. McClay*

## AGRICULTURAL ENGINEERING

FRANK W. PEIKERT, *Head of the Department*  
204 Agricultural Engineering Building

*Degree Conferred:* M.S.

*Graduate Faculty:* Professor Peikert; Associate Professors Bartlett and Walton; Assistant Professor Hovanesian.

## AGRICULTURAL ENGINEERING

Specialization is offered in farm power and machinery, electric power and processing, soil and water conservation engineering, and farm structures.

Prerequisite to major work is the completion of an undergraduate engineering curriculum from a recognized department.

### AGRICULTURAL ENGINEERING (AG E)

- 400. AGRICULTURAL ENGINEERING PROBLEMS (1-7)
- 401. FARM MECHANICS FOR TEACHERS OF VOCATIONAL AGRICULTURE (1½-9)
  - Unit A. Farm Utilities (1½)
  - Unit B. Farm Mechanics (1½)
  - Unit C. Farm Engines (1½)
  - Unit D. Farm Machinery (1½)
  - Unit E. Farm Buildings (1½)
  - Unit F. Soil and Water Structures (1½)
- 402. FUNCTIONAL DESIGN OF FARM STRUCTURES (3)
- 404. FARM MACHINERY (3)
- 405. ADVANCED FARM ELECTRIFICATION (3)
- 406. ADVANCED DAIRY ENGINEERING (3)
- 407. SOIL WATER ENGINEERING (3)
- 410. FARM POWER (3)
  
- 500. ADVANCED ELECTRO-AGRICULTURE (1-6) Investigations in the application of electrical energy to processing, storing, and handling agricultural products. Seminar, written reports.
- 501. ADVANCED FARM MACHINERY (1-6) Application of agricultural engineering principles to design and operation of farm machinery. Prerequisite: Ag.E. 410.
- 502. FARM STRUCTURES PROBLEMS (1-6) Analysis of farm structures design problems.
- 507. PROBLEMS IN SOIL WATER ENGINEERING (1-6) Analysis of engineering problems relating to irrigation, drainage, or erosion control.
- 508. ADVANCED PROBLEMS IN FARM MECHANICS (1-15) Problems in farm shop practice and agricultural engineering related to the farm mechanics program of vocational education in agriculture. Prerequisites: Ag.E. 8, 14; or teaching experience in farm mechanics.
- 509. RESEARCH IN AGRICULTURAL ENGINEERING (1-4)
- 520. AGRICULTURAL ENGINEERING SEMINAR (1-3) Reports on research and special topics.

## AGRONOMY

HOWARD B. SPRAGUE, *Head of the Department*  
118 Tyson Building

*Degrees Conferred:* Ph.D., M.S., M.Agr.

*Graduate Faculty:* Professors Carnahan, Fortmann, Higbee, Hunter, Jeffries, Kardos, Matelski, Raleigh, Richer, H. B. Sprague, V. G. Sprague, and Washko; Associate

## AGRONOMY

Professors Chandler, Cleveland, Marriott, Pfeifer, and Thomas; Assistant Professors Duich, Marshall, Ragland, and Starling.

Areas of specialization include soil chemistry; soil conservation; soil classification; soil fertility; soil mineralogy; soil physics; the breeding of corn, small grains, and forage plants; forage management; turf management; potato culture; tobacco culture; weed control; and ecology of crops and pastures. Facilities are available for X-ray diffraction, infrared and petrographic investigations of soils.

Prerequisites for major work in agronomy vary with the area of specialization, but basic courses in chemistry, mathematics, physics, and biological sciences are required. Students who lack some of the course prerequisites may be admitted but are required to take the prerequisite courses without degree credit.

### AGRONOMY (AGRO)

- |                                                              |                            |
|--------------------------------------------------------------|----------------------------|
| 411. BREEDING OF FIELD CROPS (3)                             | Mr. Thomas                 |
| 416a. SOIL CHARACTERIZATION AND CLASSIFICATION—LECTURE (4)   | Mr. Higbee                 |
| 416b. SOIL CHARACTERIZATION AND CLASSIFICATION—PRACTICUM (1) |                            |
|                                                              | Mr. Higbee                 |
| 417. FOREST SOILS (3)                                        | Mr. Matelski               |
| 419. SOIL PROPERTIES (5)                                     | Mr. Ragland                |
| 422. SOIL CONSERVATION (3)                                   | Mr. Kardos                 |
| 423. PASTURE AND GRASSLAND MANAGEMENT (3)                    | Mr. Washko                 |
| 424. FERTILIZER TECHNOLOGY (3)                               | Mr. Marriott               |
| 425. PRINCIPLES OF FIELD CROP PRODUCTION (3)                 | Messrs. Pfeifer and Thomas |
| 431. SOIL FERTILITY AND MANAGEMENT (3)                       | Mr. Marriott               |
| 490. AGRONOMIC PROBLEMS (1-6)                                | Mr. Washko and Staff       |
501. ADVANCED SOIL FERTILITY (4) Interpretation of fertility experiments and diagnosis of soil-plant relationships through field appraisal, analysis, and plant symptoms. Prerequisites: Agro. 431, Bot. 406. Spring semester, odd years. Mr. Hunter
503. AGRONOMY SEMINAR (1) Weekly meeting where papers and discussions will be presented by students and staff members. Mr. H. B. Sprague
506. SOIL CHEMISTRY (4) Analyses of important chemical and biochemical reactions occurring in soils, conditions which control these reactions and their importance in soil genesis and plant growth; laboratory work in the more typical and significant analytical procedures; lectures, review of current literature, and practicum. Prerequisites: Agro. 419; A.B.Ch. 417 or Chem. 20. Spring semester, even years. Mr. Ragland
507. SOIL PHYSICS (4) Physical properties of the soil; factors affecting them; their measurements, evaluation, and influence in determination of soil productivity. Prerequisites: Agro. 419, Phys. 215, A.B.Ch. 425. Fall semester, even years. Mr. Kardos
509. GENETICS OF CROP PLANTS (3) Inheritance in crop plants with particular reference to factor interaction, genetic aspects of linkage and crossing-over, quantitative inheritance, and heterosis. Prerequisite: Bot. (Zool.) 422. Fall semester, even years. Mr. Cleveland
510. THE APPLICATION OF CYTOGENETICS TO PLANT BREEDING (3) Cytogenetics, including chromosome structure and behavior, chromosome alterations, polyploidy, interspecific hybridization and their applications to plant breeding. Prerequisite: Bot. (Zool.) 422. Fall semester, odd years. Mr. Cleveland



512. **FIELD PLOT TECHNIQUE** (4) Ramifications of analysis of variance techniques; combining and analyzing data from several experiments; selection of valid error terms. Prerequisite: Math. 8 or Ag. 400. Fall semester. *Mr. Starling*
516. **HUMUS** (2) Origin and chemical nature of soil organic matter, its importance in soil processes, and its decomposition. Prerequisites: Agro. 419, 431. Fall semester, odd years. *Mr. Richer*
517. **FARM CROPS ECOLOGY** (2) Ecological factors influencing distribution and production of field crops. Prerequisites: Math. 8, Bot. 406. Spring semester, even years.
518. **GROWTH AND MANAGEMENT OF FORAGE CROPS** (3) Factors affecting growth and development of forage crops with particular reference to effects of environment, defoliation, and management practices. Prerequisites: Agro. 423, Bot. 406. Spring semester, odd years.
519. **THE NATURE OF SOIL MINERALS** (3) Modern methods for identification of the constituent minerals of soils and their relation to soil classification and agricultural practices. Prerequisites: Agro. 1, Chem. 2, Geol. 31. Spring semester, even years. *Mr. Jeffries*
520. **SPECIAL SOILS PROBLEMS** (1-6 per semester) Provides basic or practical training in the soils sciences by means of library, field, and laboratory assignments.
545. **THE APPLICATION OF STATISTICS TO FIELD EXPERIMENTS** (4) Use of advanced experimental designs in planning, analyzing, and interpreting experiments; includes lattice designs, factorials, confounding, simple and multiple covariance techniques. Prerequisite: Agro. 512. Spring semester. *Mr. Starling*
550. **SPECIAL CROPS PROBLEMS** (1-6 per semester) Provides basic or practical training in the crops sciences by means of library, field, and laboratory assignments.
582. **SEMINAR IN THE BREEDING AND GENETICS OF FARM CROPS** (1-8 per semester)

## ANIMAL HUSBANDRY

RUSSELL C. MILLER

*Head of the Department of Animal Industry and Nutrition*  
203 Armsby Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Bortree, Henning, and Miller; Associate Professor Gobble.

A student may specialize in animal production, animal breeding, and meats. The prerequisite for major graduate work in animal husbandry is the completion of an undergraduate curriculum in animal husbandry or a related animal science area. Students who lack some of the course prerequisites may be admitted but are required to take the prerequisite courses without degree credit.

### ANIMAL HUSBANDRY (A H)

421. **ADVANCED MEAT STUDIES** (3)  
423. **ADVANCED STOCK JUDGING** (2)  
424. **ANIMAL HUSBANDRY SEMINAR** (1)

## ANIMAL HUSBANDRY

426. (Ag.Ec. 426). LIVESTOCK MARKETING (3)

431. ADVANCED MEAT JUDGING (2)

500. SEMINAR IN ANIMAL HUSBANDRY (1-6)

501. PEDIGREE STUDY (1-6) Research work in breed study history, and analytical study of breed pedigrees, and a complete survey of the herd, flock, or stud book.

502. RESEARCH IN MEATS (1-6 per semester) Investigation of methods for handling, cutting, processing, freezing, and curing meat and meat products. Prerequisite: A.H. 421.

503. LIVESTOCK MANAGEMENT (3) Handling of purebred herds and flocks; relation of livestock breeders to the public and methods of developing purebred herds and flocks through careful breeding.

505. ADVANCED ANIMAL BREEDING (1-5) Special problems in animal genetics as applied to breeding and improvement of horses, cattle, sheep, and swine. Prerequisites: A.H. 22, Bot. (Zool.) 22.

## ANIMAL NUTRITION

RUSSELL C. MILLER

*Head of the Department of Animal Industry and Nutrition*  
203 Armsby Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Barron, Bratzler, and Miller.

For admission a student must have had A.Ntr. 401 and 402 or their equivalent and must have met the requirements for graduate work in agricultural and biological chemistry. Specialized training is offered in the area of energy metabolism. Candidates for this major select courses from a number of related fields.

### ANIMAL NUTRITION (A NTR)

401. PHYSIOLOGY OF NUTRITION (3)

*Mr. Barron*

402. PHYSIOLOGY OF NUTRITION (3)

*Mr. Barron*

## ARCHITECTURE and ARCHITECTURAL ENGINEERING

MILTON S. OSBORNE, *Head of the Department of Architecture*  
302 Sackett Building

*Degree Conferred:* M.S.

*Graduate Faculty:* Professors Hajjar, Hallock, Osborne, and Richardson; Associate Professor Reis; Assistant Professors Albright and Dill.

To enter graduate study in the field of architecture, a degree of Bachelor of Architecture, Bachelor of Science in Architecture, or Bachelor of Fine Arts in a five-year curriculum in architecture is required.

To enter graduate study in the field of architectural engineering, a degree of Bachelor of Architectural Engineering or Bachelor of Science in Architectural Engineering in a five-year curriculum is required.

## ARCHITECTURE (ARCH)

- 411. ADVANCED ARCHITECTURAL DESIGN (8)
- 412. ADVANCED ARCHITECTURAL DESIGN AND THESIS (8)
- 421. (A.A.H. 421) CONTEMPORARY ARCHITECTURE (3)
  
- 501. ARCHITECTURAL DESIGN (4-8) Problems in advanced planning and design, including study of group composition. Practicum and seminar.  
*Mr. Osborne and Staff*
- 502. ARCHITECTURAL RESEARCH (2-12) Prosecution of assigned problems under the guidance of an instructor.  
*Mr. Osborne and Staff*
- 503. ARCHITECTURAL HISTORY RESEARCH (3-12) Original research in architectural history. Seminar and written reports.  
*Mr. Dickson and Staff*

## ARCHITECTURAL ENGINEERING (A E)

- 401. ARCHITECTURAL ENGINEERING (3)
- 402. ARCHITECTURAL ENGINEERING (4)
- 403. ARCHITECTURAL ENGINEERING (3)
- \*430. ARCHITECTURAL ENGINEERING (3)
- 431. ARCHITECTURAL ENGINEERING (3)
- 432. ARCHITECTURAL ENGINEERING (4)
- \*433. ARCHITECTURAL ENGINEERING THESIS (2)
- †434. ARCHITECTURAL ENGINEERING THESIS (5)
- 451. FUNDAMENTALS OF NUCLEAR DEFENSE PLANNING AND DESIGN (3)
  
- 502. ARCHITECTURAL ENGINEERING (3-8) Advanced structural design in steel and reinforced concrete. Lectures and class criticism. Practicum and seminar.  
*Mr. Richardson and Staff*
- 503. ARCHITECTURAL ENGINEERING (4-8) Continuation of A.E. 502 in which problems of wind bracing in tall buildings, rigid frames, and heavy-framed constructions are studied. Practicum and seminar.  
*Mr. Richardson and Staff*
- 504. ARCHITECTURAL ENGINEERING (4-8) Statically indeterminate stresses in steel and reinforced concrete buildings; area moment, slope deflection, and moment distribution methods. Recitation and seminar.  
*Mr. Richardson and Staff*
- 551. ADVANCED NUCLEAR DEFENSE PLANNING AND DESIGN I (3) Weapons effects data; dynamic strength of materials and structural elements; dynamic design; architectural, structural, electrical, and mechanical requirements for shelters. Prerequisites: A.E. 4, 5, 451; E.Mch. 12.  
*Messrs. Albright and Dill*
- 552. ADVANCED NUCLEAR DEFENSE PLANNING AND DESIGN II (3) Blast-resistant design of framed structures, shear wall structures, arches, domes, and underground structures; radiation shielding characteristics of building materials. Prerequisites: A.E. 431, 432, 551; Phys. 237.  
*Messrs. Albright and Dill*
- 553. SELECTED PROBLEMS IN NUCLEAR DEFENSE RESEARCH (1-6) Prerequisite or concurrent: A.E. 451.  
*Messrs. Albright and Dill*

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\*Effective fall of 1964. Until that date students should register for A.E. 420 and 423 instead of A.E. 430 and 433.

†Effective spring of 1965. Until that date students should register for A.E. 424 instead of A.E. 434.



## ART

BEN EUWEMA, *Acting Director, School of the Arts*  
105 Sparks Building

*Degree Conferred:* M.A.

*Graduate Faculty:* Professors Hyslop, Weisman, and Zoretich; Associate Professor Enggass; Assistant Professor Shobaken.

Students may specialize in studio work or in the history of art and architecture. For admission at least 18 credits of undergraduate work in art are required. The graduate program is contingent upon the student's undergraduate preparation. If an inadequacy exists, the student will be required to make up the deficiency without degree credit.

## ART (ART)

- 400. ADVANCED OIL PAINTING (3-12)
- 410. WATER-COLOR PAINTING: LANDSCAPE, STILL LIFE, AND FIGURE (3-9)
- 420. APPLIED DESIGN (3-9)
- 431. SCULPTURE (2-6)
- 440. PRINTMAKING (2-6)
- 490. LIFE DRAWING (3)
- 500. ART RESEARCH (2-6) Prosecution of assigned problems under the guidance of an instructor.
- 510. ADVANCED PAINTING (2-12)
- 531. ADVANCED SCULPTURE (2-12)
- 540. ADVANCED PRINTMAKING (2-12)

## ART AND ARCHITECTURAL HISTORY (A A H)

- 409. MOVEMENTS IN CONTEMPORARY ART (3-6)
- 413. PROBLEMS IN ART HISTORY (3-6 per semester)
- 421. (Arch. 421). CONTEMPORARY ARCHITECTURE (3)
- 448. HISTORY OF PRINTS AND DRAWINGS (3)
- 502. SEMINAR IN MEDIEVAL ART (3-6) Original research into problems dealing with the art of the middle ages.
- 503. ART HISTORY RESEARCH (3-6) Original investigation in art history, to be pursued independently or concurrently with course work in particular fields.
- 505. SEMINAR IN BAROQUE ART (3-6) Investigations in the area of Baroque art centering around major masters and monuments.
- 506. SEMINAR IN MODERN ART (3-6) Lectures, readings, reports, and discussions in the field of modern art.
- 508. SEMINAR IN AMERICAN ART (3-6) Studies in the field of American art involving original research.

## ART—MUSIC—THEATRE (A M T)

- 400. CONTEMPORARY FORMS IN ART, MUSIC, THEATRE I (3)
- 401. CONTEMPORARY FORMS IN ART, MUSIC, THEATRE II (3)

## ART EDUCATION

EDWARD L. MATTIL, *Head of the Department*  
106 Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professor Mattil; Associate Professors Beittel, Chomicky, and Pappas.

It is generally expected that students admitted to work toward a master's degree have one year of teaching experience and present the equivalent of an approved four-year art education curriculum. A student may not receive his doctor's degree without having had at least two years of successful teaching experience.

## ART EDUCATION (A ED)

- 402. PROFESSIONAL ORIENTATION OF THE ART TEACHER (3)
- 404. METHODS OF GRAPHICS AND ILLUSTRATIONS (3)
- 414. ADVANCED CRAFTS FOR TEACHERS (3-6)
- 420. CERAMICS FOR TEACHERS (3)
- 434. ART APPRECIATION IN THE EDUCATIONAL PROGRAM (3)
- 434b. ART IN THE ELEMENTARY SCHOOL (2-3)
- 434c. ART IN THE SECONDARY SCHOOL (3)
- 434d. ART SUPERVISION (3)
- 486. CURRENT PROBLEMS IN ART EDUCATION (2-3)
- 487. MURAL PAINTING IN SCHOOLS (3)
- 488. ADVANCED MURAL PAINTING IN SCHOOLS (3)
- 489. ART EXPERIENCES WITH CHILDREN (3)
  
- 504. ADVANCED METHODS IN GRAPHIC PROCESSES (3) Exploration through laboratory experience of printing method: etching, silk screen, linoleum, or other; applications in teaching.
  
- 514. FUNCTIONAL RELATIONSHIPS IN CRAFTS (3) Relationships of material design and purpose in crafts discussed by means of outstanding products of different materials, periods, and cultures. Prerequisite: 6 credits in crafts or 3 in design and 3 in advanced crafts.
  
- 516. ANALYSIS OF THREE-DIMENSIONAL PROCESSES IN ART (3) Three-dimensional processes analyzed with regard to kinetic, textural, form, and other functions.
  
- 520. ADVANCED CERAMIC ART (3) Intensified exploration of throwing, glazing, and firing processes as related to aesthetic considerations in contemporary art forms and past cultures. Prerequisite: A.Ed. 420.
  
- 534. CREATIVE ART ACTIVITY FOR THE HANDICAPPED (3) Specific methods for development of creative art activity with the physically, mentally, emotionally, and socially handicapped; adjustive effect upon them. Prerequisite: 6 credits in art education or 6 in special education or 6 in psychology.
  
- 586. RESEARCH IN ART EDUCATION (3-9) Current experiments in art education; required of students working for a master's degree in art education. *Mr. Beittel*

588. HISTORY OF ART EDUCATION (3) Historical development of philosophies in art education in the United States and abroad.

## BACTERIOLOGY

ROBERT W. STONE, *Head of the Department*  
204 Patterson Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Cone, Dunne, Ludwig, Reid, and Stone; Associate Professors Gentry, Heist, Lindstrom, and Zimmerman; Assistant Professors Casida and Kinsloe.

Specialized areas of study include bacterial physiology, soil microbiology, food and industrial microbiology, immunology, and virology. There is opportunity for research in animal disease in co-operation with the Department of Veterinary Science.

Prerequisites for admission are 20 semester hours of chemistry including quantitative analysis and organic chemistry, and 20 semester hours of biological science including 8 hours of microbiology. It is possible to substitute additional chemistry credits for part of the biology requirement.

### BACTERIOLOGY (BACT)

- 401. GENERAL MICROBIOLOGY (4)
  - 407. BACTERIOLOGY PROBLEMS (2-9)
  - 410. IMMUNOLOGY AND SEROLOGY (4)
  - 411. BACTERIOLOGICAL SURVEY (1)
  - 412. ADVANCED BACTERIOLOGY (4)
  - 413. SOIL MICROBIOLOGY (3)
  - 414. FOOD MICROBIOLOGY (4)
  - 416. INDUSTRIAL MICROBIOLOGY (4)
506. RESEARCH (1-15 per semester) Special problems in microbiology.
507. SEMINAR (1 per semester) Reports on current fields of research.
508. PHYSIOLOGY OF BACTERIA (2) Composition, nutrition, and growth of microorganisms; influence of physical and chemical environment on metabolism.
- 508a. LABORATORY IN PHYSIOLOGY OF BACTERIA (2) Laboratory work to accompany the lectures given in Bact. 508.
509. FERMENTATION (2) Chemical activities of microorganisms; mechanisms of fermentative and oxidative metabolism.
510. LABORATORY IN FERMENTATION (2) Laboratory procedures and problems in fermentation to accompany Bact. 509.
512. BACTERIOLOGICAL TECHNIQUES (1-6) Practice in special laboratory techniques including manometry, tissue culture, and serology.
515. (V.Sc. 515). VIROLOGY (2-4) Rickettsial and viral agents parasitizing man, animals, and microorganisms. Prerequisite: Bact. 410.



516. BACTERIAL GENETICS (2-4) Mechanisms of variation in microorganisms including mutation, adaption, sexual recombination, transduction, and transforming factors. Prerequisite: 3 credits each in bacteriology and genetics.

## BIOLOGICAL SCIENCE

LEON R. KNEEBONE, *Chairman of the Committee on Biological Science*  
117 Buckhout Laboratory

*Degrees Conferred:* D.Ed., M.Ed.

The program in biological science is designed primarily to meet the needs of secondary school science teachers. The academic degrees M.S. and Ph.D. are not offered in biological science but are available in agricultural and biological chemistry, bacteriology, botany, entomology, genetics and breeding, plant pathology, and zoology.

In order to enter a program for a higher degree with a major in biological science, the candidate should present 30 credits in the natural sciences, including at least one year of chemistry, and 18 credits in education, including educational psychology and practice teaching. As many as 6 credits may be made up as undergraduate deficiencies after the candidate is admitted to the Graduate School.

The candidate for the M.Ed. degree must take at least 24 credits in the biological sciences, except in certain instances when as many as 9 of these may be taken in the physical sciences and/or mathematics. In addition, at least 6 credits in educational foundations and a term paper are required.

A reading knowledge of one foreign language is required for the D.Ed. degree.

## BOTANY

J. E. LIVINGSTON  
*Head of the Department of Botany and Plant Pathology*  
206 Buckhout Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Fergus, Grove, Kneebone, Kribs, Livingston, Wahl, and Wright; Associate Professors Grun, Hill, and Kovar; Assistant Professors Hillson and Hovin.

The student majoring in botany may specialize in any one of the branches of this subject, such as plant anatomy, cytology, ecology, genetics, morphology, mycology, physiology, plant pathology, and taxonomy. In order to enter graduate work in this field, a student should present 27 credits of undergraduate work in botany or 21 credits in botany and 6 in biological science. As many as 6 credits may be made up as undergraduate deficiencies after the candidate has been admitted to the Graduate School.

In addition to its excellent facilities for research in various phases of botany, genetics, and plant pathology, the department is equipped with a Gamma Radiation Laboratory for the study of irradiation effects upon plants and other facets of radiation biology.

See also "Plant Pathology" and "Genetics and Breeding."

# BOTANY

## BOTANY (BOT)

400. COMPARATIVE PLANT MORPHOLOGY (4) Mr. Hillson
405. (Zool. 405). GENERAL CYTOLOGY (3) Mr. Grun
406. PLANT PHYSIOLOGY (4)
407. PLANT ANATOMY (3) Mr. Kribs
409. PLANT ECOLOGY (3) Mr. Kovar
414. TAXONOMY OF VASCULAR PLANTS (3) Mr. Wahl
418. BOTANICAL PROBLEMS (1-6)
419. (P.Path. 419). MYCOLOGY (3) Mr. Fergus
421. BOTANICAL TECHNIQUE (3) Mr. Grove
422. (Zool. 422). ADVANCED GENETICS (3) Messrs. Wright and Grun
424. COMMERCIAL TROPICAL WOODS (3) Mr. Kribs
433. (Zool. 433). GENETICS, EUGENICS, AND EVOLUTION FOR TEACHERS (3) Messrs. Wright and Grun
500. PLANT PHYSIOLOGY SEMINAR (1 per semester) Selected topics from recent literature; staff and student reports on current research. Spring semester, even years.
501. THE PHYSIOLOGY OF THE FUNGI (3) Chemical composition, metabolism, toxic and stimulating agencies, spore germination, growth and irritability of the fungi. Prerequisites: Bot. 406, 419, and preferably Chem. 32. Fall semester, even years. Mr. Fergus
505. (Zool. 505). CYTOLOGY AND CYTOGENETICS (3) Chromosome mechanism of heredity; relationship between plant and animal evolution and breeding and changes in chromosomes; cytological and cytochemical techniques. Prerequisite: Bot. (Zool.) 405 or 422. Mr. Grun
506. COMPARATIVE ANATOMY OF VASCULAR PLANTS (3) Structure of the Tracheophyta from a phylogenetic standpoint. Prerequisite: Bot. 407. Spring semester, even years. Mr. Kribs
511. ADVANCED PLANT PHYSIOLOGY (3) Physiology of plants including energy relations, synthesis, and metabolism. Prerequisite: Bot. 406. Fall semester. Mr. Fritz
512. ADVANCED PLANT PHYSIOLOGY (3) Continuation of Bot. 511. Physiology of plants including nutrition, growth, and development. Prerequisite: Bot. 406. Spring semester.
516. ECOLOGICAL PLANT GEOGRAPHY (3) Distribution of plant communities; environmental factors which influence their present distribution; geological-historical development of plant communities, their past distribution. Prerequisite: Bot. 409. Fall semester, even years. Mr. Kovar
518. BOTANICAL PROBLEMS (1-15 per semester)
521. MOLDS, YEASTS, AND ACTINOMYCETES (3) Morphology and taxonomy of fungi important in microbiology; identification and techniques of study. Spring semester, even years. Mr. Fergus
522. (P.Path. 522). MYXOMYCETES, PHYCOMYCETES, AND ASCOMYCETES (4) Morphology, taxonomy, phylogeny, and life histories; identification and field work. Prerequisite: Bot. (P.Path.) 419. Fall semester, odd years. Mr. Fergus
523. (P.Path. 523). BASIDIOMYCETES AND FUNGI IMPERFECTI (4) Morphology, taxonomy, phylogeny, and life histories. Prerequisite: Bot. (P.Path.) 419. Spring semester, even years. Mr. Fergus

524. (Zool. 524). SEMINAR IN GENETICS (1 per semester)  
Messrs. Wright and Grun
525. STRUCTURE OF ECONOMIC PLANTS (3) Developmental and reproductive features of field and vegetable crops. Spring semester, odd years. Mr. Grove
526. PHOTOMICROGRAPHY OF PLANT TISSUES (2) Prerequisite: Bot. 421 or Zool. 31 or W.U. 37. Spring semester, even years. Mr. Kribs
- 527a,b. PLANT BIOLOGY FOR TEACHERS (3 each) (a) Structure and physiology; (b) reproduction processes, development and relationships of plant groups. Methods of obtaining materials and setting up experiments. Designed for teachers and prospective teachers. Prerequisite: general biology or general botany courses. Summer only; a and b given in alternate years. Bot. 527a must be taken before 527b.
528. (Zool. 528). POPULATION GENETICS (3) Factors affecting gene frequency, genotype frequency, genotype-environmental interaction, and genetic relationship in natural and artificial populations. Fall semester, odd years.
532. ADVANCED SYSTEMATIC BOTANY (2) Taxonomic principles including taxon concepts and criteria, nomenclature, classificatory systems, geographic distribution, speciation, and taxonomic literatures. Prerequisite: Bot. 14 or 414. Fall semester, odd years. Mr. Wahl
533. (Zool. 533). PROBLEMS IN GENETICS (2-6) Problems to suit needs of individual students; conferences and laboratory work. Prerequisite: Bot. (Zool.) 422. Messrs. Wright and Grun
534. MORPHOLOGY OF NONVASCULAR PLANTS (4) Classification, structure, development, and phylogenetic relationships of algae, liverworts, and mosses. Prerequisite: Bot. 421. Spring semester, odd years. Mr. Hillson
535. MORPHOLOGY OF THE TRACHEOPHYTA EXCLUSIVE OF ANGIOSPERMS (3) Origin, developmental tendencies, structure, and paleobotanical evidence. Fall semester, odd years. Mr. Grove
536. MORPHOLOGY OF ANGIOSPERMS (3) Floral origin and development, fertilization, embryogeny, seed and fruit development. Spring semester, even years. Mr. Grove
537. (Sec.Ed. 537, Zool. 537). WORKSHOP IN THE BIOLOGICAL SCIENCES (3) Projects designed for teachers of biology in the secondary schools. Summer only.

## BUSINESS ADMINISTRATION

ROBERT L. CLEWETT

*In Charge of Graduate Programs in Business Administration*  
122 Boucke Building

*Degrees Conferred:* Ph.D., M.S., M.B.A.

*Graduate Faculty:* Professors Bradley, Cook, Hexner, G. K. Nelson, Saylor, Waters, and Wherry; Associate Professors Babione, Beik, Clewett, Colwell, Kautz, Kniffin, Martin, Pashek, Phalan, Richards, and Schrader; Assistant Professors Bowlin and Carzo.

The M.B.A. program is designed for those desiring professional training in business administration, regardless of their undergraduate background, in preparation for a



## BUSINESS ADMINISTRATION

career in either business or teaching. An applicant with little or no training in business administration may be admitted to the M.B.A. program and may schedule necessary preparatory courses while pursuing the graduate program. Three credits are required as preparatory courses in each of the following: accounting, business law, business statistics, economics, finance, management, and marketing.

The M.S. and Ph.D. degrees with a major in business administration are designed for those interested primarily in research and teaching.

For admission to these programs, a minimum of 18 acceptable undergraduate credits in the fields of accounting, commerce, economics, and business statistics—including at least 6 in economics and 3 in business statistics—is required. An applicant may be admitted with slight specific deficiencies which must be made up without degree credit.

Applicants for the various graduate programs in business administration are required to take the Admission Test for Graduate Study in Business given by the Educational Testing Service and used by leading graduate business schools throughout the country to supplement other criteria for admission. Candidates are strongly urged to take the test at the earliest possible date. The test will be given at University Park and at numerous locations in most states and foreign countries in November, February, April, and July. For dates and locations see the *Bulletin of Information*, Admission Test for Graduate Study in Business, published by the Educational Testing Service, 20 Nassau Street, Princeton, New Jersey. Applicants should read the bulletin carefully. All arrangements for taking the test must be made directly with the Educational Testing Service.

### ACCOUNTING (ACCTG)

- 401. ADVANCED ACCOUNTING (3)
- 403. ADVANCED AUDITING (3-9)
- 404. COST AND BUDGETARY CONTROL (3)
- 406. ADVANCED FEDERAL TAX ACCOUNTING (3)
- 407. C.P.A. PROBLEMS (3)
- 408. GOVERNMENTAL ACCOUNTING (3)
- 409. MACHINE AND ELECTRONIC ACCOUNTING METHODS (3)
  
- 500. ACCOUNTING SEMINAR (3-6)
  
- 502. MANAGERIAL ACCOUNTING (3-6) Accounting techniques as control devices in business and industry; the use of quantitative data for policy decisions.
  
- 520. PROBLEMS IN ACCOUNTING (3-6) Planned individual projects involving library, laboratory, or field work.

### COMMERCE (COM)

- 406. INVESTMENT ANALYSIS (3)
- 408. CASE STUDIES IN BANKING AND FINANCE (3)
- 418. ESTATE PLANNING (3)
- 424. MARKETING RESEARCH (3)
- 427. RETAIL BUYING AND MERCHANDISING (3)
- 461. REGULATION OF TRANSPORT CARRIERS (3)
- 462. PROBLEMS IN TRADE AND TRANSPORTATION (3)
- 491. URBAN LAND UTILIZATION (3)
  
- 500. CASE STUDIES IN BUSINESS ADMINISTRATION (3) Case studies of business and

## BUSINESS ADMINISTRATION

management policy with respect to procurement, production, selling, finance, accounting, relations with government, labor, and the public.

- 501. COMMERCE SEMINAR (3-6) Reports on research in selected fields of commercial activities.
- 502. SEMINAR IN BUSINESS MANAGEMENT (3-6)
- 503. TRANSPORTATION AND PUBLIC UTILITY SEMINAR (3-6)
- 504. PROBLEMS IN COMMERCE (3-6) Planned individual projects involving library, laboratory, or field work.
- 506. SEMINAR IN INVESTMENTS AND CORPORATION FINANCE (3-6)
- 517. INTERNATIONAL BUSINESS PRACTICES (3) Practices of exporters and importers dealing in commodities traded in world markets under competition, monopoly, or governmental control. Prerequisite: Com. 162.
- 523. SEMINAR IN MARKETING (3-6) Research in modern marketing trends.
- 525. CASE STUDIES IN INSURANCE (3-6) Analysis of management's insurance problems, such as the feasibility of self-insurance; proper allocation of insurance premiums and coverage in selected industries, etc. Prerequisites: Com. 180, 280.
- 536. SALES MANAGEMENT SEMINAR (3) Principles of sales planning and administration; co-ordination of selling with advertising, promotion, production, and accounting; use of market research selling costs and budgets.
- 574. BUSINESS RESEARCH (3) A project paper, comparable in quality and scope of work to a graduate thesis, on problems of a company. Prerequisite: 15 credits of 400 and 500 courses in business administration.
- 577. ADMINISTRATIVE INTEGRATION (3) An analysis of co-ordination of the functional areas of business in relation to over-all company objectives. Prerequisite: 15 credits of 400 and 500 courses in business administration.

### MANAGEMENT (MGMT)

- 430. ADMINISTRATIVE MANAGEMENT (3)
- 435. CASES IN PUBLIC RELATIONS (3)

## BUSINESS EDUCATION

JAMES H. MOYER

*Head of the Department of Secondary Education*  
207A Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

Graduate programs provide advanced preparation for secondary school and college teachers of bookkeeping, secretarial, clerical, general business, retailing, and related subjects.

A minimum of 18 acceptable undergraduate credits in education and psychology plus a minimum of 30 credits in business and business education subjects are required for admission.

All candidates specializing in business education are encouraged to acquire a general education in the social sciences, the behavioral sciences, and the humanities.

The following courses in business education are described on page 153 under the heading Secondary Education: Sec.Ed. 456, 459, 460, 461, 462, 463, 466, 467, 468, 511, 575, 576, 577, and 578.

## CERAMIC TECHNOLOGY

G. W. BRINDLEY, *Head of the Department*  
214 Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Brindley, Buessem, and Hummel; Associate Professor Williamson; Assistant Professor Rindone.

The background for admission is a bachelor's degree in ceramics or in one of the related physical sciences. A knowledge of differential and integral calculus is required together with adequate physics and chemistry.

In view of the wide field covered by ceramic technology, the graduate courses may be selected with a bias toward physical ceramics, chemical ceramics, or glass technology. This makes it easily possible for students whose major subject for the bachelor's or master's degree has been either physics or chemistry to take appropriate graduate studies in ceramic technology.

Special facilities exist for research in the areas of clay mineralogy, phase diagram and related studies, ferrite and ferroelectric studies, glass technology, and high temperature reaction kinetics.

### CERAMIC TECHNOLOGY (CER T)

- |                                                                                                                                                                                                                      |                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| 401. CERAMIC BODIES AND GLAZES (2)                                                                                                                                                                                   | Mr. Hummel     |
| 402. PRINCIPLES OF CERAMIC ENGINEERING (3)                                                                                                                                                                           | Mr. Williamson |
| 404. CERAMIC SEMINAR (1)                                                                                                                                                                                             | Mr. Hummel     |
| 405. CERAMIC RESEARCH AND DESIGN (3)                                                                                                                                                                                 |                |
| 411. PRINCIPLES OF CERAMIC PROCESSES (2)                                                                                                                                                                             | Mr. Buessem    |
| 412. SURFACE CHEMISTRY OF CERAMIC MATERIALS (1)                                                                                                                                                                      | Mr. Weyl       |
| 415. PRINCIPLES OF GLASS TECHNOLOGY (3)                                                                                                                                                                              | Mr. Rindone    |
| 420. REFRACTORIES (2)                                                                                                                                                                                                |                |
| 430. ELECTROCERAMICS (1)                                                                                                                                                                                             | Mr. Buessem    |
| *450. CONSTITUTION AND PHYSICAL MEASUREMENTS LABORATORY (1-3)                                                                                                                                                        |                |
| 500. SEMINAR IN CERAMIC TECHNOLOGY (1-2 per semester) Current developments in ceramic technology and related fields. Required of all graduate students in ceramic technology.                                        |                |
| Mr. Brindley and Staff                                                                                                                                                                                               |                |
| 501. COLLOIDAL BEHAVIOR OF CLAYS AND MUDS (2-4) Colloidal properties of ceramic clays, glazes, drilling muds, filtering and bleaching clays, and kindred systems.                                                    |                |
| Mr. Williamson                                                                                                                                                                                                       |                |
| 503. USE OF PHASE EQUILIBRIA DATA IN CERAMIC TECHNOLOGY (2-5) Phase equilibria in unary, binary, ternary, and other systems; applications in product development and in understanding behavior of ceramic materials. |                |
| Mr. Hummel                                                                                                                                                                                                           |                |
| 506. MECHANICAL PROPERTIES OF CERAMIC MATERIALS (2-3) Experimental stress-strain-time relations in elasticity, anelasticity, plasticity, and rupture; theory of strength and control.                                |                |
| Mr. Buessem                                                                                                                                                                                                          |                |

\*Nonceramic majors may schedule selected parts of this course for 1 or 2 credits in conjunction with the relevant Cer.T. 401, 415, 420, 430.



507. THERMAL PROPERTIES OF CERAMIC MATERIALS (2-3) Heat capacity, heat of fusion, thermal conductivity, and thermal expansion in relation to macroscopic measurements and basic atomic concepts applied to ceramic materials.
508. DIELECTRIC AND MAGNETIC PROPERTIES OF CERAMIC MATERIALS (2-3) Preparation and properties of ceramic semiconductors, dielectrics and magnetic materials. *Mr. Buessem*
510. SEMINAR IN GLASS TECHNOLOGY (1-2 per semester) Current developments in glass technology and related fields. *Mr. Rindone*
511. CHEMICAL ASPECTS OF THE CONSTITUTION OF GLASS (1-3 per semester) Historical development, properties, and atomistic interpretation of changes of properties with compositions, temperature, and past history. *Mr. Weyl*
512. PHYSICAL ASPECTS OF THE CONSTITUTION OF GLASS (1-3) Atomic structure of glass, its relation to physical properties; rheology; glass as a liquid. *Mr. Brindley*
515. SPECIAL PROBLEMS IN CERAMIC TECHNOLOGY (1-6 per semester) Advanced individual study on a problem in ceramics.
516. SELECTED TOPICS IN CERAMIC TECHNOLOGY (1-3 per semester) Intensive group study of special topics.
517. RESEARCH INSTRUMENTS AND EQUIPMENT (2) Applications of fundamental laws and principles in research instruments; care, adjustment, and effective use of instruments and equipment (demonstrations).
530. (Min. 530). STRUCTURE, PROPERTIES, AND OCCURRENCE OF CLAY MINERALS (2-5) Structure analysis and identification of clay minerals; mineral transformation and behavior; occurrence, genesis, and petrography of fine-grained sediments. *Messrs. Brindley, Bates, and Griffiths*

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in ceramic technology studies are listed under Mineral Sciences in Part II of this bulletin. The subject of color in glasses is treated in Min. 521.

## CHEMICAL ENGINEERING

MERRELL R. FENSKE, *Head of the Department*  
131 Chemical Engineering Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Fenske, Quiggle, and Rose; Associate Professors Carnahan, Hersh, Jones, Klaus, and McCormick; Assistant Professor Lloyd.

Course offerings or research facilities are available in the following areas: phase equilibria, thermodynamics, unit operations, unit processes, nuclear chemical engineering, petroleum technology, rheology, and lubrication. The facilities for instruction and research in chemical engineering and petroleum chemistry include those of the Petroleum Refining Laboratory.

The minimum requirements for admission are 24 semester hours of chemical engineering including stoichiometry, industrial chemistry, unit operations, thermodynamics, plant design, kinetics, or chemical engineering problems; 14 semester hours of engineering including engineering mechanics, electrical engineering, or mechanical engineering basic courses; chemistry through one year of physical chemistry; and mathematics through differential equations.

## CHEMICAL ENGINEERING

Thesis research work in petroleum chemistry, for the M.S. and Ph.D. degrees in chemistry, may be done in the Department of Chemical Engineering.

### CHEMICAL ENGINEERING (CH E)

- |                                                |                         |
|------------------------------------------------|-------------------------|
| 402. CHEMICAL ENGINEERING (4)                  | Mr. Carnahan            |
| 403. CHEMICAL ENGINEERING (4)                  | Mr. Carnahan            |
| 404. CHEMICAL PLANT DESIGN (3)                 | Messrs. Engel and Lloyd |
| 405. THERMODYNAMICS FOR CHEMICAL ENGINEERS (3) |                         |
| 406. CHEMICAL ENGINEERING PROBLEMS (3)         | Messrs. Engel and Lloyd |
| 420. CRYOGENIC ENGINEERING (3)                 | Mr. Fritz               |
| 422. MOTOR FUELS (2)                           | Mr. Carnahan            |
| 430. NUCLEAR CHEMICAL ENGINEERING (3)          | Mr. Lloyd               |
500. SEMINAR IN CHEMICAL ENGINEERING (1) Required of all graduate students.
505. SPECIAL TOPICS IN CHEMICAL ENGINEERING (2-12) Intensive study in the various specialized fields of chemical engineering.
510. ADVANCED HEAT TRANSFER I (3) Physical and chemical factors controlling the rate of heat transfer under conditions of steady flow.
511. ADVANCED HEAT TRANSFER II (3) Flow of heat under varying temperature conditions.
515. DISTILLATION (3) Commercial distillation, equilibrium diagrams, vapor composition, stills and rectifying and stripping columns.
516. ECONOMIC BALANCE (3) Problem work on the design of chemical engineering equipment from the economic standpoint.
518. CHEMICAL ENGINEERING DESIGN (3) Complicated examples are discussed and worked out. Several different unit operations will be combined for the design of a complete installation.
520. EXTRACTION PROCESSES (3) Equilibrium extraction data and phase contacting and settling related to equipment design.
521. MASS TRANSFER (3) Problem course on developments in diffusion, fluid dynamics, and phase equilibrium.
524. CHEMICAL ENGINEERING, APPLICATION OF THERMODYNAMICS (3) Elements of thermochemistry and thermodynamics of greatest importance in chemical engineering.
530. HEAT TRANSFER IN NUCLEAR REACTORS (3) Fluid flow, heat transfer, and design problems in nuclear reactor systems. Mr. Lloyd
535. APPLIED REACTION KINETICS (3) Basic principles of chemical kinetics, simultaneous heat and mass transfer, and prediction of rates; their application to reactor design.

## CHEMISTRY

THOMAS WARTIK, *Head of the Department*  
212 Whitmore Laboratory

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Aston, Deno, Fenske, Fleming, Hutchison, Jordan,



Miller, Noll, Oakwood, Quiggle, Seward, Skell, Smith, Sommer, Taft, Wartik, Willard, and Zook; Associate Professors Ascah, Dixon, Fritz, Goodman, Haas, Hayes, Holtzinger, Jones, Klaus, and Schempf; Assistant Professors Benson, Currie, Gingerich, Lotz, Richey, Schmulbach, Shamma, and Steele.

Students may specialize in analytical, inorganic, organic, physical, and petroleum chemistry. The general facilities for instruction and research in the major fields of chemistry are excellent, while the cryogenic, microscopy, petroleum, radiochemical, and spectroscopy laboratories provide unusual research opportunities.

Entering graduate students should have had training which includes at least one year's work in each of the following: general chemistry, analytical chemistry, organic chemistry, physical chemistry, and general physics. Mathematics through integral calculus is required, and a reading knowledge of at least one foreign language, preferably German, is expected.

Prior to scheduling their first semester's program, new students will take examinations in the four areas of analytical, inorganic, organic, and physical chemistry. The information obtained from these tests will assist both the student and his adviser in making up a program best suited to the student's needs. These examinations are normally given just prior to the regular registration period.

## CHEMISTRY (CHEM)

400. CHEMICAL LITERATURE (1) *Mrs. Strauss*  
 401. SEMINAR (1)  
 405. NUCLEAR AND RADIOCHEMISTRY (3) Breakage ticket \$5. *Messrs. Currie and Miller*  
 410. ADVANCED INORGANIC CHEMISTRY (4) Breakage ticket \$5.  
 413. INORGANIC PREPARATIONS AND LABORATORY METHODS (2-5) Breakage ticket \$5.  
 420. ADVANCED ANALYTICAL CHEMISTRY (4) Breakage ticket \$10. *Messrs. Hayes, Jordan, and Schempf*  
 426. INSTRUMENTAL METHODS OF ANALYSIS (3-5) Breakage ticket \$10. *Messrs. Hayes, Jordan, and Schempf*  
 435. ORGANIC PREPARATIONS AND LABORATORY METHODS (3-5) Breakage ticket \$10. *Mr. Oakwood*  
 437. QUALITATIVE ORGANIC ANALYSIS (3) Breakage ticket \$5. *Messrs. Oakwood and Noll*  
 440. ADVANCED PHYSICAL CHEMISTRY (3) *Messrs. Hutchison and Seward*  
 441. ADVANCED PHYSICAL CHEMISTRY (2) *Messrs. Fritz and Taft*  
 448. COLLOID CHEMISTRY (3) Breakage ticket \$5. *Mr. Benson*  
 \*460-461. INTRODUCTORY PHYSICAL CHEMISTRY (3 each)  
 \*462. EXPERIMENTAL PHYSICAL CHEMISTRY (1) Breakage ticket \$5.  
 \*463. EXPERIMENTAL PHYSICAL CHEMISTRY (1) Breakage ticket \$5.  
 \*464-465. PHYSICAL CHEMISTRY (3 each)  
 470. CHEMICAL MICROSCOPY (3) Breakage ticket \$5. *Miss Willard*  
 471. SPECIAL TOPICS IN CHEMICAL MICROSCOPY (2-6) Breakage ticket \$5. *Miss Willard*  
 472. QUANTITATIVE ORGANIC MICROANALYSIS (3) Breakage ticket \$5. *Mr. Fleming*  
 474. QUANTITATIVE ORGANIC MICROANALYSIS (3) Breakage ticket \$5. *Mr. Fleming*  
 477. CHEMICAL PHOTOMICROGRAPHY (3) Breakage ticket \$5. *Miss Willard*  
 489. INTRODUCTION TO CHEMICAL RESEARCH (3-5) Breakage ticket \$10.

\*Graduate credit not allowed for students majoring in chemistry or chemical engineering.



## CHEMISTRY

- †490. ORGANIC CHEMISTRY (5) Breakage ticket \$5.  
 †491. ORGANIC CHEMISTRY (5) Breakage ticket \$10.  
 492a. ADVANCED GENERAL CHEMISTRY FOR TEACHERS (3)  
 493. SELECTED TOPICS IN CHEMISTRY FOR TEACHERS (3)  
 494. CHEMICAL DEMONSTRATIONS FOR TEACHERS (3)
500. SEMINAR IN INORGANIC CHEMISTRY (1 per semester)  
 501. SEMINAR IN PHYSICAL CHEMISTRY (1 per semester)  
 502. SEMINAR IN ORGANIC CHEMISTRY (1 per semester)  
 503. SEMINAR IN ANALYTICAL CHEMISTRY (1 per semester)
516. SYSTEMATIC INORGANIC CHEMISTRY (3) Systematic treatment of inorganic chemistry in terms of modern concepts. *Messrs. Wartik and Haas*  
 517. CHEMISTRY OF THE LESS FAMILIAR ELEMENTS (3) Continuation of Chem. 516. *Messrs. Wartik and Haas*
518. SPECIAL TOPICS IN INORGANIC CHEMISTRY (3 per semester) Modern developments in specialized fields.
525. ANALYTICAL PROCESSES (3) Separative and determinative processes in analytical chemistry. *Messrs. Hayes, Jordan, and Schempf*  
 526. MODERN INSTRUMENTAL ANALYSIS (3) *Messrs. Hayes, Jordan, and Schempf*  
 527. SPECIAL TOPICS IN ANALYTICAL CHEMISTRY (2-12) *Messrs. Hayes, Jordan, and Schempf*
531. SPECIAL TOPICS IN ORGANIC CHEMISTRY (3-12)
532. ORGANIC NITROGEN COMPOUNDS (3) Chemistry, stereochemistry, and molecular structure of organic compounds containing nitrogen. *Mr. Aston*
534. THEORETICAL ORGANIC CHEMISTRY (3) Modern theories of structure; resonance; interpretation of physical properties; theory of rates; equilibrium properties. *Mr. Aston*
- 535-536. ORGANIC CHEMISTRY (3 each) Adapted to the needs of those doing research work in organic chemistry. *Mr. Zook*
537. ORGANIC CHEMISTRY OF HIGH POLYMERS (3) High polymer theory and practice from the viewpoint of organic chemistry.
538. ORGANIC CHEMISTRY (3) Survey of organic chemistry arranged primarily for graduate students majoring in fields other than organic chemistry. *Messrs. Noll and Oakwood*
539. STEREOCHEMISTRY (3) Comprehensive treatment of the principles of stereochemistry as applied to organic compounds. *Mr. Oakwood*
540. EXPERIMENTAL METHODS OF PHYSICAL CHEMISTRY (3-5)
541. PHASE RULE (3) The phase rule and its applications.
542. COLLOIDS (3) The physics and chemistry of surfaces and their resulting colloid properties; methods of preparing colloids. *Mr. Smith*
544. CHEMICAL THERMODYNAMICS (3) Development of thermodynamic theory

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†Candidates for the M.Ed. degree.

with special reference to common physical changes and chemical reactions. Pre-requisite: Chem. 461. *Messrs. Aston and Fritz*

545. CHEMICAL THERMODYNAMICS AND INTRODUCTORY STATISTICAL MECHANICS (3) Continuation of Chem. 544 including the calculation of thermodynamic properties from molecular and spectroscopic data. Prerequisite: Chem. 544. *Messrs. Aston and Fritz*

546. QUANTUM CHEMISTRY (3) Calculation of electronic properties of atoms and molecules by wave mechanical methods including molecular orbital theory. Pre-requisite: Chem. 565. *Messrs. Aston and Goodman*

547. STATISTICAL MECHANICS (3) Properties of matter at equilibrium, developed on the basis of energy levels of molecules and statistical mechanical theory. Pre-requisite: Chem. 565. *Mr. Aston*

548. CATALYSIS (3) Theory of catalysis and its application to industry.

549. PHYSICAL CHEMISTRY OF HIGH POLYMERS (3) Physicochemical principles related to the properties of synthetic and natural polymeric systems.

560. TOPICS IN PHYSICAL CHEMISTRY (3-12)

561-562. CHEMICAL PRINCIPLES (3 each) Mathematical treatment of the classical principles of chemistry; their application to problems. Required of all graduate students. Prerequisites: Chem. 461, Math. 43, Phys. 285. A course in organic chemistry is recommended.

563. CHEMICAL KINETICS (3) Theory and measurement of the rates of chemical reactions; the mechanism of chemical reactions. *Messrs. Ascah and Taft*

564. CHEMICAL KINETICS (3) Continuation of Chem. 563 but including theory and measurement of photochemical reactions. *Messrs. Ascah and Taft*

565. ATOMIC AND MOLECULAR STRUCTURE (3) Introduction to modern theoretical chemistry: chemical bonds and molecular spectra.

567. ADVANCED THEORETICAL CHEMISTRY (3) Modern and current theories of the properties of chemical substances and their applications to chemical problems; the construction of chemical theory.

581. EXPERIMENTAL METHODS IN PETROLEUM CHEMISTRY (1-12)

582. TOPICS IN PETROLEUM CHEMISTRY (2-6)

## CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS

WINONA L. MORGAN, *Head of the Department*  
105E Home Economics South

*Degrees Conferred:* M.S., M.Ed. in the general field of Child Development and Family Relationships; Ph.D., D.Ed. in Child Development and in Family Relationships.

*Graduate Faculty:* Professors Britton, Harms, Morgan, and Smith; Associate Professors Broderick and Siegel.

Students may specialize in the guidance and development of children, relationships among various members of the family, problems of all stages of the family cycle, nursery school education, education for home and family living in the schools, parental education, and work with children and families in community agencies.

The entering student should have had at least 6 credits in the physical and biological sciences, 12 in the social sciences (which must include a basic course in sociology



## CHILD DEVELOPMENT

and one in psychology), and 6 in child development and family relationships. Students who are otherwise qualified but who lack some of these credits may be admitted and permitted to make up the deficiency credits along with a graduate program.

### CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS (CD FR)

- |                                                                                                                                                                                                                                       |                                    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| 418. FAMILY RELATIONSHIPS (3)                                                                                                                                                                                                         | <i>Messrs. Hobbs and Broderick</i> |
| 429. ADVANCED CHILD DEVELOPMENT (3)                                                                                                                                                                                                   | <i>Mr. de Lissovoy</i>             |
| 430. OBSERVATION AND EXPERIENCE IN NURSERY SCHOOL (1-4)                                                                                                                                                                               | <i>Miss Russell</i>                |
| 441. NURSERY SCHOOL ORGANIZATION (3)                                                                                                                                                                                                  | <i>Miss Russell</i>                |
| 445. (Psy. 445). DEVELOPMENT THROUGHOUT ADULTHOOD (3)                                                                                                                                                                                 | <i>Mr. Britton</i>                 |
| 481. EDUCATIONAL METHODS WITH PRESCHOOL CHILDREN (3)                                                                                                                                                                                  | <i>Miss Russell</i>                |
| 500. NONTHESIS RESEARCH (1-6)                                                                                                                                                                                                         |                                    |
| 508. PARENTAL EDUCATION (3) Discussion and use of methods, experiences, and programs which can be used effectively to help parents in dealing with problems of parent-child relationships. Prerequisites: C.D.F.R. 429, 430.          | <i>Miss Morgan</i>                 |
| 515. THE TEACHING OF CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS (3) Methods of selection and presentation of subject matter basic to understanding the development of children.                                                       | <i>Miss Morgan</i>                 |
| 529. (Psy. 529). SEMINAR IN CHILD DEVELOPMENT (1-6) Readings and reports on recent findings in child development. Prerequisites: 6 credits in child development or 6 in educational or child psychology, plus 3 in statistics.        |                                    |
| 530. PROBLEMS IN CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS (1-6) Problems involving individual research in library, laboratory, or field projects.                                                                                   |                                    |
| 539. THEORIES OF CHILD DEVELOPMENT (3) Historical background of the major theories concerning child development and behavior and their application.                                                                                   | <i>Mrs. Siegel</i>                 |
| 545. THE FAMILY IN ITS COMMUNITY (3) Cultural influences on family relationships; how the family orients its members to community living and group participation.                                                                     | <i>Mr. Broderick</i>               |
| 546. SEMINAR IN FAMILY RELATIONSHIPS (1-6) Reading, reports, and discussion of recent research in relationship aspects of family living; particular attention to studies of roles, crises, and adjustments within the family setting. | <i>Mr. Broderick</i>               |

## CIVIL ENGINEERING and SANITARY ENGINEERING

BENJAMIN A. WHISLER, *Head of the Department of Civil Engineering*  
208 Sackett Building

*Degrees Conferred:* Civil—Ph.D., M.S., M.Eng.; Sanitary—M.S., M.Eng.  
*Graduate Faculty:* Professors Kountz, Perez, Reen, Shulits, and Whisler; Associate Professors Moore, Nesbitt, and Underwood.

The entering student should be a graduate in civil engineering from an accredited college of engineering. Students may specialize in structures, hydraulics, transportation engineering, surveying, and sanitary engineering, or combinations of these, through courses offered both by the Department of Civil Engineering and by other departments of the University.



## CIVIL ENGINEERING (C E)

400. SEMINAR (1-3)
  401. CIVIL ENGINEERING PROJECTS (2-12)
  412. ADVANCED PHOTOGRAMMETRY (3)
  421. HIGHWAYS AND STREETS (3)
  423. HIGHWAY SAFETY AND TRAFFIC CONTROL (3)
  431. CIVIL ENGINEERING CONSTRUCTION (3)
  441. STATICALLY INDETERMINATE STRUCTURES (3)
  442. STATICALLY INDETERMINATE STRUCTURES (3)
  446. ADVANCED SOIL MECHANICS (3)
  451. ADVANCED HYDROLOGY (3)
  462. ADVANCED HYDRAULICS (3)
  465. ELEMENTS OF HYDRAULIC ENGINEERING (3)
  466. HYDRAULIC MACHINERY (3)
  471. MUNICIPAL AND RURAL SANITATION (3)
  472. TREATMENT PLANTS (4)
  473. WATER AND SEWAGE ANALYSIS (3)
- 
500. SEMINAR IN CIVIL ENGINEERING (1-6) Reports on researches and special topics. Course may be continued in subsequent semesters.
  521. TRANSPORT PLANNING AND DESIGN (2-6) Planning and design of transportation facilities; basic principles and engineering techniques applied to airways, highways, pipe lines, railways, waterways. Prerequisite or concurrent: C.E. 51 or 421.
  522. TRANSPORT OPERATION AND MAINTENANCE (2-6) Engineering problems in operation, maintenance, and administration of airways, highways, pipe lines, railways, waterways. Prerequisite or concurrent: C.E. 51 or 421.
  540. ADVANCED STRUCTURAL ANALYSIS (2-4) Geometry of flexure, deflections; analysis of continuous beams, rigid frames, arches; influence lines. Prerequisite: C.E. 40.
  541. ADVANCED STRUCTURAL ANALYSIS (2-4) Truss deflection; trusses with redundant members, continuous trusses, framed arches; influence lines; secondary stresses; wind stresses; space framework; suspension bridges. Prerequisite: C.E. 40.
  542. APPLIED SOIL MECHANICS (2-5) Soil classification by type of clay minerals and profile development; aerial photographic interpretation of soils and applications to site selection for dams, highways, and airports. Prerequisites: C.E. 412, 446.
  543. STRUCTURAL ENGINEERING PROJECTS (3-10) Investigation or design projects in concrete, soil mechanics, photoelasticity, analysis, etc. Prerequisite or concurrent: C.E. 441, 442.
  544. ADVANCED STRUCTURAL DESIGN (2-4) Plain and reinforced concrete design as applied to buildings, bridges, retaining walls, domes, tanks, and dams; prestressed concrete. Prerequisites: C.E. 42, 442.
  545. ADVANCED STRUCTURAL DESIGN (2-4) Structural steel design as applied to riveted and welded girders, trusses, rigid frames, wind connections; timber design. Prerequisite: C.E. 41.
  547. ADVANCED STRUCTURAL THEORY (3-6) Prestressed concrete, arches, suspension bridges, concrete dams, thin shells, and other current topics. Prerequisites: C.E. 441, 442.
  550. ENGINEERING CONSTRUCTION (2-4) Construction methods applied to foundations, buildings, bridges, and other civil engineering construction work. Prerequisites: C.E. 41, 42.

## CIVIL ENGINEERING

551. HYDROLOGIC INVESTIGATIONS (2-8) Application of hydrologic principles and techniques to a specific project. Prerequisite: C.E. 451.
560. DIMENSIONAL ANALYSIS AND THEORY OF MODELS (3) Principles of dimensional analysis and similitude with engineering applications.
564. HYDRAULIC ENGINEERING DESIGN (2-8) Design and analysis of selected units of a typical hydraulic engineering project.
565. TRANSPORTATION OF SOLIDS BY FLUIDS (2-5) Fundamentals of the flow of solids in open and closed conduits; e.g., suspended load and bed load in rivers, slurries and pulp stocks in pipes.
566. FLUID MECHANICS OF HYDRAULIC MACHINERY (3) Advanced theory and design of hydraulic machinery. Prerequisite: C.E. 466.
570. RURAL SANITATION DESIGN (3) Requirements and devices essential to rural sanitary problems: water supply, excreta disposal, industrial waste treatment. Not intended for civil or sanitary engineering students. Prerequisites: Chem. 4, Phys. 285.
571. WATER PURIFICATION AND SOFTENING (3) Current methods of softening, disinfecting, and conditioning water for municipal and industrial use. Prerequisite: C.E. 70.
572. SEWAGE TREATMENT (3) Modern methods of sewage treatment. Prerequisite: C.E. 70.
573. ADVANCED PROBLEMS IN SANITARY ENGINEERING (3-10)
575. ADVANCED INDUSTRIAL WASTE TREATMENT (3) Techniques of industrial waste treatment; attendant stream pollution and stream self-purification factors. Prerequisite: C.E. 472 or 572.
576. WATER TREATMENT PLANT DESIGN (1-6) Design of works for treatment of water for municipal and industrial use. Prerequisite: C.E. 71.
577. SEWAGE TREATMENT PLANT DESIGN (1-6) Design of works for treatment of sewage or industrial wastes. Prerequisite: C.E. 71.
578. INDUSTRIAL HYGIENE (3) Principles of control of industrial toxics and the protection of the worker and the community.
579. PUBLIC HEALTH ADMINISTRATION (3) Operation and duties of health departments at the various levels.

## CLINICAL SPEECH

EUGENE T. McDONALD, *Director of the Speech and Hearing Clinic*  
2S Sparks Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professor McDonald; Associate Professors Berlin, Frick, and Siegenthaler; Assistant Professor Raabe.

Students may specialize in either speech correction or audiology. Admission to study for the master's degree requires 27 semester hours in clinical speech and hearing, education, and psychology courses. These must include at least 9 credits in speech correction and/or audiology. Applicants for the M.S. degree must have had a course

## CLINICAL SPEECH

in statistics; applicants for the M.Ed. degree must have had student teaching. Applicants for the M.S. degree may count credits in speech science toward the required 27 hours.

### SPEECH EDUCATION (SP ED)

430. HEARING PROBLEMS AND THE TESTING OF HEARING (3)  
434. AUDIOMETRY AND HEARING AIDS (3)  
435. CLINICAL PRACTICE WITH THE HEARING HANDICAPPED (1-6)  
    Unit A. *Audiologic Evaluation and the Selection of Hearing Aids* (1-4)  
    Unit B. *Auditory Training and Speech Reading* (1-4)  
436. INTRODUCTION TO SPEECH CORRECTION (3)  
437. CLINICAL PRACTICE IN SPEECH CORRECTION (1-3)  
440. SPEECH EDUCATION FOR THE CLASSROOM TEACHER (2-3)  
441. CURRENT PROBLEMS IN SPEECH AND HEARING (1-6)  
442. SPEECH PATHOLOGY (3)  
443. METHODS IN AUDITORY TRAINING AND SPEECH READING (3)  
445. THE PUBLIC SCHOOL SPEECH CORRECTION PROGRAM (3)
525. SEMINAR IN CLINICAL SPEECH PATHOLOGY (3-9) Prerequisites: Sp.Ed. 436, 442.  
    Unit A. *Cleft Palate*  
    Unit B. *Cerebral Palsy*  
    Unit C. *Aphasia*
530. SEMINAR IN AUDIOLOGY (2-4) Review of theories of hearing and review of related physiological and psychological researches. Prerequisite: Sp.Ed. 434.
537. ADVANCED CLINICAL PRACTICE IN SPEECH CORRECTION (1-9) Prerequisites: Sp.Ed. 437, 442.  
    Unit A. *Diagnostic Procedures* (1-3)  
    Unit B. *Treatment Procedures* (1-6)
540. ARTICULATION DISABILITIES (3) Speech-sound production disorders in children and adults; methods of examination, diagnosis, and treatment. Prerequisites: Sp.Ed. 437, 442.
541. THE VOICE AND ITS DISORDERS (3) Physical, physiological, and psychological bases of voice production; causes, nature, and symptoms of its disorders; current clinical methods in voice improvement. Prerequisites: Sp.Ed. 437, 442.
542. STUTTERING AND ALLIED DISORDERS (3) Modern theories of causes of disorders of rhythm; methods of examination, diagnosis, and treatment. Prerequisites: Sp.Ed. 437, 442.
543. DIAGNOSTIC PROCEDURES IN CLINICAL SPEECH (3) Clinical instrumentation; case history taking; examination procedures and materials used in diagnosing speech disabilities; interpretation of findings; report preparation. Prerequisites: Sp.Ed. 437, 442.

## CLOTHING AND TEXTILES

RUTH W. AYRES, *Head of the Department*  
116A Home Economics Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professor Ayres; Associate Professors Densmore and Gates.



## CLOTHING AND TEXTILES

Work may be taken with major emphasis in the textile area, which stresses the background natural sciences, or in the clothing area, which stresses the background social sciences. Candidates are accepted who have a strong foundation and a good record in any of the following: home economics, chemistry, sociology, economics, or psychology.

### CLOTHING AND TEXTILES (CL TX)

- |                                                                     |                                                                                                                                                           |
|---------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 400. SPECIAL PROBLEMS IN CLOTHING AND TEXTILES (1-6)                |                                                                                                                                                           |
| 402. FUNDAMENTAL PRINCIPLES OF TAILORING CONSTRUCTION (3)           | <i>Mrs. Larson</i>                                                                                                                                        |
| 403. CREATIVE PATTERN MAKING (3)                                    | <i>Mrs. Larson</i>                                                                                                                                        |
| 404. DRAPING (3)                                                    | <i>Mrs. Larson</i>                                                                                                                                        |
| 406. FASHION PROMOTION (3)                                          |                                                                                                                                                           |
| 407. THE TEXTILE AND CLOTHING INDUSTRY (3)                          | <i>Miss Ayres</i>                                                                                                                                         |
| 408. INTERMEDIATE TEXTILES (3)                                      | <i>Miss Densmore</i>                                                                                                                                      |
| 410. CLOTHING FOR THE FAMILY (3)                                    |                                                                                                                                                           |
| 411. ADVANCED CLOTHING CONSTRUCTION (3)                             | <i>Mrs. Larson</i>                                                                                                                                        |
| 413. TEXTILE TECHNOLOGY (3)                                         | <i>Miss Densmore</i>                                                                                                                                      |
|                                                                     |                                                                                                                                                           |
| 500. NONTHESIS RESEARCH (1-6)                                       |                                                                                                                                                           |
| 503. ADVANCED PATTERN DEVELOPMENT (3)                               | Analysis of advanced pattern designing principles to give students facility in original designing.                                                        |
| 504. ADVANCED DRAPING (3)                                           | Analysis of principles and techniques as a basis for creation of original designs; survey of literature in dress design.                                  |
| 505. CLOTHING INSTRUCTIONAL MATERIALS (3)                           | Development of instructional materials and techniques based on needs of diverse groups.                                                                   |
| 506. THE FASHION WORLD (3)                                          | <i>Miss Gates</i>                                                                                                                                         |
| 507. PROBLEMS IN RELATION TO CLOTHING CONSUMPTION (3)               | Problems connected with manufacture and consumption of clothing; interrelation of textile and clothing trades with other industries.<br><i>Miss Ayres</i> |
| 508. SPECIAL PROBLEMS IN CLOTHING AND TEXTILES (1-6)                | Individual directed study, investigation, and practice in selected phases of textiles and clothing.                                                       |
| 509. SEMINAR IN CLOTHING AND TEXTILES (1-6)                         |                                                                                                                                                           |
| 510. RESEARCH METHODS AND EVALUATION IN CLOTHING AND TEXTILES (1-6) | <i>Misses Densmore and Gates</i>                                                                                                                          |
| 511. CURRENT DEVELOPMENTS IN CLOTHING AND TEXTILES (1-6)            |                                                                                                                                                           |
| 512. HISTORY OF CLOTHING AND CLOTHING CONSTRUCTION (3)              | <i>Miss Gates</i>                                                                                                                                         |
| 513. ADVANCED TEXTILE TECHNOLOGY (6)                                | <i>Miss Densmore</i>                                                                                                                                      |

## COMPARATIVE LITERATURE

PHILIP A. SHELLEY  
*Chairman of the Committee on Comparative Literature*  
229 Sparks Building

*Degrees Conferred:* Ph.D., M.A.

Programs are arranged through a meaningful selection of courses offered by the several departments of languages and literatures, both ancient and modern, as well

## COMPARATIVE LITERATURE

as of those specifically in the category of comparative literature. More than a minimum knowledge of foreign languages is required.

### COMPARATIVE LITERATURE (C LIT)

400. COMPARATIVE METHOD IN LITERARY STUDIES (3)  
443. (Ger. 443). LITERARY RELATIONS OF GERMANY WITH ENGLAND AND AMERICA (3-9) *Mr. Shelley*  
480. INTRODUCTION TO FOLKLORE (3) *Mr. Bayard*  
500. SEMINAR IN COMPARATIVE LITERATURE (3-6)  
508. NORSE AND GAELIC SAGAS (3) Medieval Irish and Scandinavian prose tales surveyed and compared with respect to backgrounds, development, themes, and characteristics.

## COUNSELING IN EDUCATION

GEORGE R. HUDSON, *in Charge of the Graduate Program*  
418 McAllister Hall

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professor Wellington; Associate Professor Hudson; Assistant Professor Hylbert.

Professional preparation programs are offered at the master's level for elementary or secondary school counselors, home and school visitors, college counselors, and rehabilitation counselors. Doctoral programs prepare for pupil personnel administration, college student personnel administration, or supervision of rehabilitation.

All candidates for graduate degrees in counseling in education must present for admission at least 27 undergraduate credits in economics, education, psychology, sociology, and physiology or anatomy, with some credits in at least three of these areas.

Prospective school counselors and home and school visitors must have a teaching certificate to enter the program and must have two years of teaching experience before receiving a degree. Those wishing to become college counselors must have a year of college teaching or college personnel experience to qualify for a degree. Since graduate students in rehabilitation counseling combine a supervised internship with professional training, their master's degree program is correspondingly lengthened.

A candidate for either a Ph.D. or a D.Ed. degree in counseling in education must spend at least two semesters in residence after earning the master's degree; during this time his employment load must be limited to half-time at most, the balance of his time being devoted to graduate study.

The following courses are used in the graduate programs of majors in counseling in education: Ed.Ser. 403, 404, 408, 409, 490, 494, 503, 505, 506, 507, 508, 509, 511, 512, 522, 545, 551, 598, 600, or 610; Psy. 414, 418, 426, 436, 437, 445, 450, 482, 502, 535; Soc. 403, 426, 427, 450; Pl.Sc. 433; Anthy. 402; Econ. 404.

## DAIRY SCIENCE

DONALD V. JOSEPHSON, *Head of the Department*  
105 Dairy Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Almquist, Doan, Josephson, Patton, and Williams;

## DAIRY SCIENCE

Associate Professors Flipse, Kesler, and Watrous; Assistant Professors Keeney and O'Dell.

Students may specialize in dairy products manufacture, chemistry of milk and dairy products, dairy cattle nutrition, dairy cattle management, and physiology of reproduction. The minor program is generally taken in agricultural and biological chemistry, bacteriology, zoology, or agricultural economics.

Prerequisite to graduate work is the completion of an undergraduate curriculum in dairy science or a related science area. The undergraduate program must include college algebra and general physics. Students may be admitted with limited deficiency but are required to make up undergraduate deficiency work without degree credit.

### DAIRY SCIENCE (D SC)

- |                                                     |                             |
|-----------------------------------------------------|-----------------------------|
| 418. DAIRY SURVEY (1)                               | <i>Mr. Josephson</i>        |
| 421. TECHNICAL CONTROL PROBLEMS (1-10)              | <i>Mr. Doan and Staff</i>   |
| 427. MILK SECRETION (3)                             | <i>Mr. Kesler</i>           |
| 428. DAIRY PRODUCTION PROBLEMS (1-6)                | <i>Mr. Kesler and Staff</i> |
| 431. PHYSIOLOGY OF REPRODUCTION IN FARM ANIMALS (3) | <i>Mr. Almquist</i>         |
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- |                                                                                                                                                     |                               |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| 501. BUTTER AND CHEESE (1-6) Manufacture and handling of butter and cheese.<br>Prerequisites: D.Sc. 10, 23, Bact. 8, A.B.Ch. 403.                   | <i>Mr. Watrous</i>            |
| 502. CONDENSED MILK AND MILK POWDER (1-6) Condensing and drying of milk.<br>Prerequisites: D.Sc. 10, 26, Bact. 8, A.B.Ch. 403.                      | <i>Mr. Doan</i>               |
| 503. PUBLIC MILK PROBLEMS (1-6) Handling milk in modern plants. Prerequisites: D.Sc. 11, Bact. 8, A.B.Ch. 403.                                      | <i>Mr. Doan</i>               |
| 504. ICE CREAM MANUFACTURE (1-6) Manufacture of ice cream, ices, and other frozen milk products. Prerequisites: D.Sc. 11, Bact. 8, A.B.Ch. 403.     | <i>Mr. Keeney</i>             |
| 505. DAIRY PLANT ECONOMICS (1-6) Economic factors involved in creamery operation and management. Prerequisites: D.Sc. 7, 11.                        | <i>Mr. Watrous</i>            |
| 507. DAIRY CATTLE MANAGEMENT (1-6) Management of dairy cattle. Prerequisite: D.Sc. 27.                                                              | <i>Mr. Williams and Staff</i> |
| 508. DAIRY SEMINAR (1-6) Preparation and presentation of a paper on an assigned subject.                                                            | <i>Mr. Patton and Staff</i>   |
| 509. TESTING DAIRY PRODUCTS (1-6) Constituents of dairy products. Prerequisites: D.Sc. 11, Bact. 8, A.B.Ch. 403.                                    | <i>Mr. O'Dell</i>             |
| 510. DAIRY CATTLE FEEDING (1-6) Application of fundamental research in animal nutrition to the feeding of dairy cattle. Prerequisites: D.Sc. 1, 29. | <i>Mr. Williams</i>           |
| 511. DAIRY CATTLE NUTRITION (1-6) Nutritional requirements of dairy cattle. Prerequisite: A.Ntr. 401.                                               | <i>Mr. Kesler</i>             |
| 512. ADVANCED STUDIES IN MILK SECRETION (1-6) Physiology of milk secretion. Prerequisite: D.Sc. 427.                                                | <i>Mr. Kesler</i>             |
| 513. DAIRY CATTLE SELECTION (1-6) Breed history, pedigrees, selection, and judging of dairy cattle. Prerequisites: D.Sc. 1, 30.                     |                               |
| 515. ADVANCED PHYSIOLOGY OF REPRODUCTION IN FARM ANIMALS (1-6)                                                                                      | <i>Mr. Almquist</i>           |



516. ARTIFICIAL BREEDING OF FARM ANIMALS (1-6) Prerequisite: D.Sc. 431.  
Mr. Almquist
517. DAIRY SCIENCE LITERATURE (1-6) Review and reporting of dairy literature.  
Mr. Josephson and Staff
522. RESEARCH PROCEDURES IN DAIRY TECHNOLOGY (3) Research problems and methods in dairy technology with major emphasis on dairy chemistry. Prerequisite: A.B.Ch. 403.  
Mr. Patton

## ECONOMICS

MONROE NEWMAN, *Head of the Department*  
124 Boucke Building

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Professors Cutler, Fouraker, Hench, Hexner, Kaufman, Mason, Reede, Saylor, and Stout; Associate Professors Kautz, Mares, Myers, Newman, Sauerlender, and Werboff; Assistant Professors Klein and Prybyla.

Opportunities are available for concentration in business statistics, economic theory, labor, international economics, government economic policy, money, credit, and public finance.

To enter graduate work in economics a student should have completed 6 credits in economic principles, 9 in the social sciences, and either 3 in statistics or 6 in mathematics.

### BUSINESS STATISTICS (B S)

500. SEMINAR IN BUSINESS STATISTICS (3)  
501. ADVANCED BUSINESS STATISTICS (3)

### ECONOMICS (ECON)

400. HISTORY OF ECONOMIC THOUGHT (3)  
404. ECONOMIC FRAMEWORK OF MODERN SOCIETY (3)  
405. INTERMEDIATE ECONOMIC THEORY (3)  
406. ECONOMIC GROWTH AND DEVELOPMENT (3)  
412. ECONOMICS OF COLLECTIVE BARGAINING (3)  
415. SOCIAL INSURANCE (3)  
418. ECONOMICS OF WAGES AND EMPLOYMENT (3)  
419. CASE STUDIES IN LABOR-MANAGEMENT RELATIONS (3)  
423. STATE AND LOCAL TAXATION (3)  
425. THE MONEY MARKETS (3)  
428. INCOME AND EMPLOYMENT THEORY (3)  
429. FEDERAL FINANCES (3)  
433. INTERNATIONAL MONETARY ECONOMICS (3)  
434. INTERNATIONAL TRADE AND PUBLIC POLICY (3)  
442. MONOPOLY, COMPETITION, AND THEIR REGULATION (3)  
450. THE BUSINESS CYCLE (3)  
480. MATHEMATICAL ECONOMICS (3)  
490. MEASUREMENT OF THE ECONOMY (3)  
499. FOREIGN STUDY IN ECONOMICS (2-6)
500. ECONOMICS SEMINAR (3-6)

## ECONOMICS

501. RESEARCH METHODS IN ECONOMICS (3-6)
506. PROBLEMS IN ECONOMICS (3-6) Planned individual projects involving library, laboratory, or field work.
507. SEMINAR IN INTERNATIONAL ECONOMICS: THEORY AND POLICY (3-6) Spring semester, even years.
508. SEMINAR IN MONEY, CREDIT, AND PUBLIC FINANCE (3-6) Prerequisite: Econ. 51. Spring semester, odd years.
510. ECONOMETRICS (3) Statistical estimation in mathematically formulated economic relationships. Spring semester, even years.
511. SEMINAR IN INDUSTRIAL DISPUTES (3) Prerequisites: Econ. 14, 15. Fall semester, even years.
512. WAGES (3) Fall semester, odd years.
513. DEVELOPMENT OF ECONOMIC DOCTRINES (3-6) Prerequisite: Econ. 405. Spring semester.
515. LABOR SEMINAR (3) Spring semester.
522. ADVANCED ECONOMIC THEORY (3-6) Theory of price and income determination. Prerequisite: Econ. 405. Fall semester, micro; spring semester, macro.

## EDUCATIONAL ADMINISTRATION

FRANKLIN A. MILLER

*Head of the Department of Educational Services*  
207E Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Bixby, Cologne, Davison, DeLacy, McGarey, Miller, Neuber, and Remaley; Associate Professors Bosch and McAulay; Assistant Professors Page and Willower.

Professional preparation programs are offered at the master's level for elementary and secondary school principals and supervisors. Doctoral programs prepare for positions of supervising principal, assistant superintendent, and superintendent of schools.

Requirements for admission to a graduate program in educational administration include 18 approved undergraduate credits in education and psychology. Applicants for admission to the master's degree program are required to have had one year of teaching experience, or to be currently engaged in teaching. Two years of teaching experience are required for admission to the doctoral program.

Candidates may minor in either educational foundations or in a field outside of education. While candidates are required to specialize in a field of professional education, they are also encouraged to acquire a general education in the social sciences, the behavioral sciences, and the humanistic foundations.

The following courses in educational administration are listed under the offerings of the Department of Educational Services: Ed.Ser. 480 and 565 to 582 inclusive. Additional courses may be selected from other areas and departments to meet the student's needs, including certification requirements.

# EDUCATIONAL SERVICES

## DEPARTMENT OF EDUCATIONAL SERVICES

FRANKLIN A. MILLER, *Head of the Department*  
207E Burrowes Building

The Department of Educational Services offers graduate programs in counseling in education, clinical speech, educational administration, and higher education. It also offers a number of course sequences which are not graduate majors.

The following courses, designated as Educational Services, carry graduate credit and, with the approval of the student's adviser, may be applied toward the requirements for an advanced degree in any major field:

	ED.SER.
Adult Education	460-462
Counseling in Education	403-409, 503-513
Educational Administration	480, 565-582
Higher Education	545-555
History and Philosophy of Education	415-424, 516-523
Instructional Materials	435-445, 535-541
Research, Seminars, and Projects	596-599
Safety Education	450-452
Special Education	425-431, 525-529
Testing and Measurements	490-494, 590-595

### EDUCATIONAL SERVICES (ED SER)

- 403. GUIDANCE PRINCIPLES AND PRACTICES (3)
- 404. TEACHING AND GROUP GUIDANCE ABOUT OCCUPATIONS (3)
- 408. INTRODUCTION TO VOCATIONAL REHABILITATION (3)
- 409. MEDICAL INFORMATION FOR COUNSELORS (3)
- 415. CHARACTER EDUCATION (2-3)
- 417. PHILOSOPHIC BASIS OF EDUCATION (3)
- 418. HISTORY OF EDUCATION IN THE UNITED STATES (2-3)
- 419. MODERN TENDENCIES IN AMERICAN EDUCATION (1-6)
- 420. HISTORY OF MODERN EUROPEAN EDUCATION (3)
- 424. RELIGIOUS EDUCATION (2-3)
- 425. EDUCATION OF EXCEPTIONAL CHILDREN (2-3)
- 427. EDUCATION OF THE MENTALLY RETARDED (2-3)
- 429. EDUCATION OF THE MENTALLY GIFTED CHILD (1-3)
- 430. PRACTICUM IN THE EDUCATION OF ATYPICAL CHILDREN (1-8)
- 431. ATYPICAL CHILDREN AND EDUCATIONAL ADJUSTMENTS (3)
- 435. VISUAL AND OTHER SENSORY AIDS FOR TEACHERS (1-3)
- 436. PREPARATION OF EDUCATIONAL STILL PICTURES (2-3)
- 437. SCRIPTING AND SHOOTING EDUCATIONAL MOTION PICTURES (2-3)
- 438. EDITING AND SOUND RECORDING IN THE PRODUCTION OF EDUCATIONAL MOTION PICTURES (2-3)
- 441. ORGANIZATION AND ADMINISTRATION OF VISUAL-SENSORY AIDS PROGRAMS (1-3)
- 442. MOTION PICTURES IN EDUCATION (2-3)
- 443. RADIO AND TELEVISION IN EDUCATION (3)
- 444. STILL PICTURES (1-2)
- 445. ADVANCED AUDIO-VISUAL EQUIPMENT (3)
- 450. VISUAL AND OTHER AIDS IN SAFETY EDUCATION (3)
- 451. TEACHING TRAFFIC SAFETY AND AUTOMOBILE OPERATION (3)
- 452. ORGANIZATION AND SUPERVISION IN SAFETY EDUCATION (3)
- 460. HISTORY, PHILOSOPHY, AND GENERAL ORGANIZATION AND ADMINISTRATION OF ADULT EDUCATION (1)



## EDUCATIONAL SERVICES

- 461. ORGANIZATION, TYPES, AND METHODS OF ADULT EDUCATION AND PARENTAL EDUCATION (1)
- 462. METHODS IN ADULT EDUCATION AND LEADERSHIP OF DISCUSSION GROUPS (1)
- 480. EDUCATIONAL ADMINISTRATION (2-3)
- 490. EDUCATIONAL STATISTICS AND MEASUREMENTS (2-3)
- 494. EDUCATIONAL TESTING PROGRAMS (3)
  
- 503. GUIDANCE SERVICES IN ELEMENTARY EDUCATION (3) Guidance services to elementary school students; guidance opportunities for elementary teachers and principals.
- 505. OCCUPATIONAL AND EDUCATIONAL INFORMATION (3) Occupational information for guidance purposes; educational information related to vocational choice and preparation. Prerequisite: Ed.Ser. 403.
- 506. STUDENT ANALYSIS PROCEDURES FOR COUNSELORS (3) Collection and use of data basic to the counselor's understanding of individuals; the counseling interview and techniques other than testing.
- 507. SUPERVISED EXPERIENCE IN STUDENT COUNSELING (3) Practice in the application of guidance principles and methods to cases counseled under supervision; case conferences; seminar in guidance techniques. Prerequisite: Ed.Ser. 403.
- 508. ORGANIZATION AND ADMINISTRATION OF GUIDANCE PROGRAMS (3) Principles, organization, personnel, functions, integration with school programs, evaluation. Prerequisite: Ed.Ser. 403.
- 509. CONTRIBUTION OF PROFESSIONAL PERSONNEL TO VOCATIONAL REHABILITATION (3) Contributions of medical, social, psychological, and other specialists through the team approach; professional ethics, medical problems. Prerequisites: Ed.Ser. 403, 408.
- 511. SUPERVISED PRACTICUM IN REHABILITATION COUNSELING (1-6) Application of principles and techniques of rehabilitation counseling to cases involving handicapped individuals. Prerequisites: Ed.Ser. 403, 408.
- 512. PROFESSIONAL EXPERIENCE IN REHABILITATION COUNSELING (1-6) Supervised internship with responsibility for a regular case load. Prerequisite: Ed.Ser. 511.
- 513. SUPERVISION OF GUIDANCE WORKERS (3) Practical experience in supervising and evaluating work of counselors. Prerequisite: Ed.Ser. 507.
- 516. SOCIAL FOUNDATIONS OF EDUCATION (2-4) Social institutions and functions and their relationship to public education; analysis of the functions assignable to formal education. Prerequisites: El.Ed. 311 or Sec.Ed. 252; Psy. 14.
- 517. ADVANCED PHILOSOPHY OF EDUCATION (2-4) Analysis of educational policy and practice for philosophic consistency and commitment; philosophical implication in selected educational literature.
- 518. EVOLUTION OF EDUCATIONAL THOUGHT (2-3) Rise of formal educational philosophy from Plato to John Dewey; preliminary reference to Chinese, Hindu, Chaldean, Persian, Hebrew, and Egyptian theories.
- 521. EDUCATION IN THE LATIN-AMERICAN COUNTRIES (2-3) Recent educational progress in Central and South America, with special reference to Mexico, Cuba, Puerto Rico, Brazil, Chile, and Argentina.
- 522. COMPARATIVE EUROPEAN EDUCATION (3) Educational policies and practices in school systems in western and central European nations. Prerequisite: Psy. 14.

523. **EDUCATION IN RUSSIA, ASIA, AND THE MIDDLE EAST (2-3)** Current educational activities in Soviet Russia and other eastern European countries; the Middle East, North Africa, and the Far East.
525. **INTERNSHIP IN SPECIAL EDUCATION SUPERVISION (3-6)** Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
527. **PROBLEMS IN THE EDUCATION OF THE MENTALLY RETARDED (1-4)** Study of existing curriculums, instructional practices, educational programs; experimentation in curriculum building and materials construction. Prerequisites: teaching experience; Ed.Ser. 425 or 577, and Ed.Ser. 427.
529. **PROBLEMS IN THE EDUCATION OF THE MENTALLY GIFTED (1-4)** Analysis of educational needs of mentally gifted; curriculum construction and curricular materials. Prerequisites: teaching experience; Ed.Ser. 425 or 577, and Ed.Ser. 429.
535. **SEMINAR IN CURRICULUM MATERIALS AND THEIR UTILIZATION (3)** Advanced detailed analysis of mass communication media; relationships among these and educational objectives, individual differences in learners, and ideas to be communicated. Prerequisites: Ed.Ser. 435, Sec.Ed. 585, 6 credits in educational psychology.
540. **INTERNSHIP IN AUDIO-VISUAL EDUCATION (3-6)** Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
541. **LABORATORY IN ORGANIZATIONAL ASPECTS OF MATERIALS OF INSTRUCTION (1-3)** Organizing, storing, circulating, and maintaining instructional material in an instructional materials library. Prerequisites: Ed.Ser. 435, Sec.Ed. 585. Conference 1 hour, alternate weeks by appointment.
545. **HIGHER EDUCATION IN THE UNITED STATES (2-3)** Historical perspective and current status; development of functions and structures; issues in curriculum, admissions, government, administration, and finance.
546. **THE PRINCIPLES OF COLLEGE TEACHING (2-3)** Principles involved in teaching at the college level; effective use of teaching aids; criteria used in evaluation.
547. **INTERNSHIP IN COLLEGE TEACHING (3-6)** Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
548. **CURRICULUMS IN HIGHER EDUCATION (2-3)** Various types of curriculums and philosophies underlying them; ways in which curriculums are developed; elective versus required courses; evaluation of achievement.
549. **COMMUNITY JUNIOR COLLEGE AND THE TECHNICAL INSTITUTE (2-3)** Distinctive contributions to meeting the need for post-secondary education; development, functions, curriculum and instruction, government, administration and finance.
550. **THE PROFESSIONAL EDUCATION OF TEACHERS (3)** Development and present status of teacher education; objectives and standards; selection and guidance of students; personnel problems in relation to staff. Prerequisite: 6 credits in advanced courses in education and a course in educational psychology.
551. **STUDENT PERSONNEL PROGRAMS AT THE COLLEGE LEVEL (2-3)** Student personnel services in higher education; organization of student advisory programs; use of personnel data; co-curricular activities; student welfare.
552. **ADMINISTRATION IN HIGHER EDUCATION (2-3)** Philosophy of administration; principles of scientific management and their application in colleges and universities;



## EDUCATIONAL SERVICES

- case studies of administrative problems. Prerequisite: courses or experience in higher education.
555. SEMINAR IN COLLEGIATE EDUCATION (1-6) Special topics in higher education. Prerequisite: courses or experience in higher education.
565. PRINCIPLES OF SCHOOL SUPERVISION (2-3) Organization of supervision; planning the supervisory program; developing standards of teaching and learning; improvement of learning through tests and teacher rating. Prerequisites: 18 credits in education and 3 years' teaching experience.
566. THE ELEMENTARY SCHOOL PRINCIPAL AS SUPERVISOR (2-3)
567. THE SECONDARY SCHOOL PRINCIPAL AS SUPERVISOR (2-3) Improvement of instruction; improvement of teachers in service; evaluation of teaching procedures; methods of supervision; selection and use of textbooks. Prerequisite: three years' teaching experience.
568. THE ELEMENTARY SCHOOL PRINCIPAL AS ADMINISTRATOR (2-3) Duties of the elementary school principal in organizing and administering his school.
569. THE SECONDARY SCHOOL PRINCIPAL AS ADMINISTRATOR (2-4) Problems of schedule making, teachers' meetings, curriculum making and revision, organization of extracurricular and guidance programs. Prerequisite: teaching experience.
570. ADMINISTRATION AND SUPERVISION IN BUSINESS EDUCATION (3) Work of administrators, supervisors, and others responsible for improvement of instruction in business education; use of vocational testing; job analysis. Prerequisite: 6 credits in secondary education.
571. THE EDUCATIONAL PLANT (2-3) School plant needs in terms of school population and curriculums; the building survey, developing a plant program, the building site, plant utilization, operation and maintenance, heating and ventilation, equipment, school building costs and finance. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
572. PUBLIC RELATIONS FOR SCHOOL ADMINISTRATORS (2-3) Utilization of public participation in the formulation of school policies; relation of the school staff to the public and techniques for informing the public about what schools can do. Prerequisite: Ed.Ser 480 or teaching or administrative or supervisory experience.
573. PUBLIC SCHOOL FINANCE (2-3) Financing of public education in relation to organization and control; the conceptual basis for local financial administration; taxation, state and federal aid, school revenue, and money management. Prerequisite: Ed.Ser 480 or teaching or administrative or supervisory experience.
574. STATE AND NATIONAL EDUCATION PROGRAMS (2-3) Existing state and federal functions and relations to education; proposed programs. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience, and previous work in school administration.
575. ADMINISTRATION OF ADULT EDUCATION IN THE PUBLIC SCHOOLS (3) The organization of a program of adult education; its legal status, finances, selection of teachers, learning personnel, housing, and other administrative problems connected with adult education. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
576. LEGAL ASPECTS OF SCHOOL ADMINISTRATION (3) Legal bases for the organization and administration of school districts and schools; the powers, rights, privileges, and responsibilities of school corporations, school boards, administrators, and



personnel; the law and fiscal policies; the course of study, textbooks; contracts; taxes; torts; records; agents; and the judicial decisions involved. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.

577. THE ADMINISTRATION OF PUBLIC SCHOOL EDUCATION FOR ATYPICAL CHILDREN (2-3) Problems connected with the instituting and organizing of classes for atypical children; the legal phases, finances, teaching personnel, pupil personnel, housing, equipment, courses of study, curriculum, etc. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.

578. DYNAMIC FACTORS IN SCHOOL ADMINISTRATION (2-3) Factors which make for the improvement of public schools; influences with which administrators may work to improve the schools in their local situations; subjection of data on individual administrative situations to scientific check. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.

579. PUBLIC SCHOOL BUSINESS ADMINISTRATION (2-3) Business management applied to school management problems; budgeting, accounting, purchasing, insurance, school equipment, cafeteria management; transportation, salaries, personnel management, and auxiliary and co-ordinate agencies. Prerequisites: Ed.Ser. 480 or teaching or administrative or supervisory experience; Ed.Ser. 573.

580. SEMINAR IN SCHOOL ADMINISTRATION (1-6) Efficiency in supervision, methods of diagnosis and evaluation of teaching and learning procedure, improving instruction, maintaining teacher morale, stimulating co-operative work. Prerequisites: Ed.Ser. 480, 6 credits in educational administration.

581. EDUCATIONAL SURVEY TECHNIQUES (2-3) Methods for appraisal of an educational program; planning for expansion, consolidation, or reduction of educational offerings. Prerequisites: Ed.Ser. 480, 6 credits in educational administration.

582. INTERNSHIP IN ADMINISTRATION AND SUPERVISION (1-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.

590. ADVANCED EDUCATIONAL STATISTICS (2-4) Appropriate measures and devices for experimental research in education including correlation measures, curve fitting, and analysis of variance. Prerequisite: 12 credits of graduate work in education including Ed.Ser. 490 or Psy. 415.

595. INTRODUCTION TO THE ADVANCED STUDY OF EDUCATION (1-3) Methods of educational research; criticism of studies and theses in education; initiating research projects; summarizing results of research. Prerequisite: Ed.Ser. 490 or Psy. 415.

596. SEMINAR IN EDUCATION (1-3) Conferences and discussions designed to meet the need for special study of particular fields in education. Prerequisite: 12 credits of graduate work in education.

597. WORKSHOP IN CURRENT EDUCATIONAL PROBLEMS (1-6) For administrators, supervisors, experienced elementary and secondary teachers, guidance workers; administrative, supervisory, and instructional problems involved in an emerging educational program. Prerequisite: 12 credits of graduate work in education.

598. PROBLEMS, PROJECTS, AND AREA STUDIES IN EDUCATION (1-6) Independent work in the study of topics in education or the development of new curriculums, materials, or procedures for teaching. Prerequisites: 12 credits of graduate work in education and approval of the department head.

599. INTERNSHIP IN PUBLIC SCHOOL RESEARCH (3-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.

## ELECTRICAL ENGINEERING

ARTHUR H. WAYNICK, *Head of the Department*  
105 Electrical Engineering Building

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Professors Holt, Tarpley, Volz, and Waynick; Associate Professors Armington, Atwater, Bowhill, Marsh, Pearson, Ross, Schmerling, and Shields; Assistant Professors Ferraro, Nisbet, and Somayajulu.

Course offerings and research facilities are available in the following areas: information theory, microwave theory and techniques, networks, computers (including digital, analog, and network analyzer), control, power conversion, servomechanisms, tubes and transistors, dynamical machine analysis, power dispatching, relay protection, and wave propagation.

The entering student must hold a bachelor's degree in engineering or science and have satisfactorily completed undergraduate course work in electrical circuits, machinery, and electronics.

### ELECTRICAL ENGINEERING (E E)

421a,b,c,d. ELECTRICAL ENGINEERING PROBLEMS (2-12)

422. CREATIVE ELECTRICAL ENGINEERING (3)

423. LINEAR TRANSIENT ANALYSIS (3)

425. SYMMETRICAL COMPONENTS (3)

426. TRANSISTORS (3)

428. SERVOMECHANISMS (3)

432. ULTRA-HIGH-FREQUENCY TECHNIQUES (3)

435. ENGINEERING ANALYSIS (3)

438. ELECTROMAGNETIC THEORY AND RADIATING SYSTEMS (3)

439. PULSE TECHNIQUES (3)

441. ACTIVE CIRCUITS (3)

450. ELECTRICAL NETWORK THEORY (3)

460. HIGH-VOLTAGE ENGINEERING (3)

461. FUNDAMENTALS OF POWER SYSTEM STABILITY (3)

470. ELECTRONIC ANALOG COMPUTERS (3)

471. LOGICAL DESIGN OF DIGITAL COMPUTERS (3)

520. SEMINAR (1) Required of all graduate students in electrical engineering. Conferences, reading, and presentation of technical papers.

521. ADVANCED ELECTRICAL ENGINEERING PROBLEMS (2-12)

523. NONLINEAR ANALYSIS (3) Transient and steady state response of nonlinear physical systems, mathematical and graphical techniques, stability criteria. Prerequisite: E.E. 33.

525. SYMMETRICAL COMPONENTS (3) Polyphase circuits and machines under unbalanced conditions of operation including effects of rotating machines upon distribution and transmission system performance; characteristics of phase converters and single-phase operation of polyphase systems. Prerequisite: E.E. 425.

528. SERVOMECHANISMS (3) Advanced treatment of transient and steady-state behavior of closed-cycle control systems with special attention to stability and design of stabilizing controllers. Prerequisite: E.E. 428.



## ELECTRICAL ENGINEERING

532. ULTRA-HIGH-FREQUENCY ENGINEERING (3) Theory of wave guides and discontinuities, resonant cavities, traveling wave oscillators and devices; interaction of fields with matter. Prerequisite: E.E. 432 or 438.
535. ENGINEERING ANALYSIS (3) Engineering applications of complex variables, conformal mapping methods and potential plotting. Laplace transform methods and stability criteria. Prerequisite: E.E. 435.
538. ELECTROMAGNETIC ENGINEERING (3) Electrical and magnetic fields, using the Maxwell-Lorentz equations as applied to vector fields and special solutions for antennae, wave guides, and other engineering applications. Prerequisite: E.E. 438.
550. PASSIVE NETWORK SYNTHESIS (3) Network synthesis using (a) realizability conditions; (b) image parameters, realization methods for two-terminal pair networks; rational fraction approximation; time domain synthesis. Prerequisite: E.E. 450.
570. ADVANCED ELECTRONIC ANALOG COMPUTERS (3) Theory and design of linear and nonlinear function generators for electronic analog computers; methods of synthesizing physical systems. Prerequisite: E.E. 470.
571. DIGITAL COMPUTATION AND CONTROL (3) Methods of analysis of digital computers; analysis of sampled-data systems for real-time control purposes.
581. CONSTITUTION OF THE IONOSPHERE (3) Properties of the neutral and ionized atmosphere above 60 km height; photochemical processes causing them; solar ionospheric perturbations; large-scale movements.

## ELEMENTARY EDUCATION

A. MADISON BREWER, *Head of the Department*  
109 Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Bixby, Brewer, Murphy, and Russell; Associate Professors Alessandro, Bosch, Corle, Hunt, McAulay, and Veatch.

The graduate programs provide advanced professional preparation for kindergarten teachers, elementary school teachers, and curriculum specialists. For admission 18 credits in elementary education, including teaching experience, are required.

### ELEMENTARY EDUCATION (EL ED)

426. PROBLEMS OF ELEMENTARY SCHOOL ARITHMETIC (2-3)
433. TEACHING SOCIAL STUDIES IN THE ELEMENTARY GRADES (2-3)
436. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE ELEMENTARY SCHOOL (3)
437. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE ELEMENTARY SCHOOL (3)
438. TEACHING SCIENCE IN THE ELEMENTARY SCHOOL (1-3)
443. THE ELEMENTARY SCHOOL READING PROGRAM (2-3)
444. READING DISABILITIES (2-3)
445. TECHNIQUES IN REMEDIAL READING (2-6)
449. TEACHING CHILDREN'S LITERATURE (2-3)



## ELEMENTARY EDUCATION

453. SPECIAL PROBLEMS IN THE TEACHING OF ELEMENTARY SCHOOL ENGLISH (2-3)
461. ELEMENTARY EDUCATION (2-3)
467. ADVANCED THEORY OF KINDERGARTEN (3)
479. MEASUREMENT OF ACHIEVEMENT IN THE ELEMENTARY SCHOOL (2-3)
485. WORKSHOP IN SELECTED STUDIES IN ELEMENTARY EDUCATION (1-6)
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511. SUPERVISION OF STUDENT TEACHERS (3) A course in supervision for master teachers, department heads, and college teachers with supervisory responsibilities in teacher education. Prerequisite: teaching experience and 18 credits in education, including at least 5 in methods.
520. INTERNSHIP IN ELEMENTARY EDUCATION (3-6) Internship to take place in schools or educational situations where not regularly employed under supervision of graduate faculty.
546. SEMINAR ON READING INSTRUCTION (2-12) Designed to appraise significant researches and to outline procedures and materials for research; reading readiness, word perception, basic reading skills, vocabulary development. Prerequisite: El.Ed. 443 or Sec.Ed. 443.
556. READING CLINIC PRACTICE: ANALYSIS OF READING DISABILITIES (1-9) A laboratory course consisting of analysis of extreme reading disabilities and recommended remedial procedures; experience in preparation of case reports. Prerequisite: El.Ed. 444.
557. READING CLINIC PRACTICE: REMEDIAL PROCEDURES (1-9) Practicum in special classes for reading disabilities; corrective and remedial procedures; specific procedures for correction of various types of reading disabilities. Prerequisite: El. Ed. 444 or 556.
559. READING CLINIC RESEARCH (1-15) Prerequisites: El.Ed. 443; or Sec.Ed. 443, El.Ed. 444.
562. PROBLEMS OF ELEMENTARY EDUCATION (2-3) Problems seminar for experienced educators. Prerequisite: 12 credits in education and psychology, including 6 in elementary education.
563. SEMINAR IN CONTEMPORARY ISSUES IN ELEMENTARY EDUCATION (1-3) Conferences and discussions designed to meet the needs of experienced teachers and principals in the field of elementary education. Prerequisite: 6 credits in elementary education and teaching experience.
564. ORGANIZATION OF THE ELEMENTARY SCHOOL CURRICULUM (2-3) Principles underlying curriculum construction. Primarily for elementary education majors. Prerequisite: El.Ed. 311 or teaching experience.
585. WORKSHOP IN CURRENT ELEMENTARY SCHOOL PROBLEMS (1-6) For experienced elementary school teachers, administrative, supervisory, and instructional problems involved in an emerging educational program. Prerequisite: 12 credits of graduate work in education.
594. SEMINAR IN EDUCATION (1-3) Conferences and discussions designed to meet the need for special study of particular fields in education. Prerequisite: 12 credits of graduate work in education.
598. PROBLEMS, PROJECTS, AND AREA STUDIES IN ELEMENTARY EDUCATION (1-6) Independent work in the study of topics in elementary education or the development of new curriculums, materials, or procedures for teaching. Prerequisites: 12 credits of graduate work in education and approval of the department head.

## ENGINEERING MECHANICS

JOSEPH MARIN, *Head of the Department*  
204 Engineering A

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Professors Davids, Marin, Oppel, Vierck, and Wislicenus; Associate Professors Hardenbergh and Hu; Assistant Professors Jaunzemis and Gaus.

Graduate study is available in dynamics and vibrations, theory of elasticity and strength of materials, experimental stress analysis, theory of plasticity, solid state mechanics, mechanical properties of materials, and fluid mechanics.

The entering student must hold a bachelor's degree in engineering or science and have satisfactorily completed undergraduate courses in statics, dynamics, and strength of materials.

## ENGINEERING MECHANICS (E MCH)

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|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| 400. ADVANCED STRENGTH OF MATERIALS (3)                                                                                                                                                                                                                                                                                              | <i>Mr. Hardenbergh</i>          |
| 401. ELEMENTS OF VIBRATIONS (3)                                                                                                                                                                                                                                                                                                      | <i>Mr. Vierck</i>               |
| 402. APPLIED AND EXPERIMENTAL STRESS ANALYSIS (3)                                                                                                                                                                                                                                                                                    | <i>Mr. Oppel</i>                |
| 403. MECHANICS OF THE SOLID STATE (3)                                                                                                                                                                                                                                                                                                | <i>Mr. Marin</i>                |
| 404. RESEARCH IN ENGINEERING MECHANICS (1-6)                                                                                                                                                                                                                                                                                         |                                 |
| 407. NUMERICAL METHODS OF ANALYSIS (3)                                                                                                                                                                                                                                                                                               | <i>Mr. Vierck</i>               |
| 408. ELASTICITY AND ENGINEERING APPLICATIONS (3)                                                                                                                                                                                                                                                                                     | <i>Messrs. Hu and Jaunzemis</i> |
| 409. ADVANCED MECHANICS (3)                                                                                                                                                                                                                                                                                                          |                                 |
| 410. MECHANICS OF SPACE FLIGHT (3)                                                                                                                                                                                                                                                                                                   | <i>Mr. Oppel</i>                |
| 411. DETERMINATION OF MECHANICAL PROPERTIES (3)                                                                                                                                                                                                                                                                                      |                                 |
| 412. EXPERIMENTAL METHODS IN VIBRATIONS (3)                                                                                                                                                                                                                                                                                          |                                 |
| 413. PLASTIC ANALYSIS OF STRUCTURES (3)                                                                                                                                                                                                                                                                                              | <i>Mr. Hu</i>                   |
| 500. ADVANCED MECHANICS OF MATERIALS (3-6) Strain energy methods; special problems in bending and torsion; curved bars, beams on elastic foundations; thick-walled cylinders, shrink-fit assemblies, and rotating discs; thin-walled pressure vessels; bending of thin plates; buckling of bars and plates. Prerequisite: E.Mch. 13. |                                 |
|                                                                                                                                                                                                                                                                                                                                      | <i>Mr. Marin</i>                |
| 504. APPLIED ELASTICITY (3) Analyses of stress and strain in two dimensions; problems in elasticity and elastic stability; emphasis on applications to machine and structural design. Prerequisite: E.Mch. 13.                                                                                                                       |                                 |
| 506. EXPERIMENTAL STRESS ANALYSIS (3) Experimental methods of stress determination including photoelasticity, stress coat and electric strain gauge techniques; stress analogies; strain rosettes for combined stress determinations. Prerequisite: E.Mch. 408 or 507.                                                               |                                 |
|                                                                                                                                                                                                                                                                                                                                      | <i>Mr. Oppel</i>                |
| 507. THEORY OF ELASTICITY AND APPLICATIONS (3) Equations of equilibrium and compatibility; stresses and strains in beams, curved members, rotating discs, thick cylinders, torsion and structural members. Prerequisite: E.Mch. 13.                                                                                                  |                                 |
| 508. THEORY OF ELASTIC STABILITY AND APPLICATIONS (3) Buckling of slender and short members; buckling of I-beams; stability of thin-walled constructions; thin-walled cylinders subjected to internal pressures; applications to structural parts including aircraft members. Prerequisites: E.Mch. 12, 13.                          |                                 |
| 509. THEORY OF PLATES AND SHELLS (3) Bending of circular and rectangular                                                                                                                                                                                                                                                             |                                 |



## ENGINEERING MECHANICS

- plates; buckling of plates; plates on elastic foundations; deformation of shells without bending; applications to engineering problems. Prerequisite: E.Mch. 13.  
*Mr. Oppel*
514. ENGINEERING MECHANICS SEMINAR (1 per semester) Current literature and special problems in engineering mechanics.
516. MATHEMATICAL THEORY OF ELASTICITY (3) Stress and strain dyadics; conditions for single valued displacement; incompatibility dyadic; generalized Hooke's Law; uniqueness theorem; special topics in elasticity. Prerequisites: Math. 417, 405.  
*Mr. Jaunzemis*
520. ADVANCED DYNAMICS (3) Dynamics of a particle and of rigid bodies: Newtonian equations in moving co-ordinate systems; Lagrange's and Hamilton's equations of motion; special problems in vibrations and dynamics. Prerequisites: E.Mch. 12, Math. 44 or 431.  
*Mr. Davids*
522. THEORY OF VIBRATIONS (3) Mathematical theory of vibrating systems; damping phenomena; forced vibrations; analogy between mechanical and electrical vibrations; transverse and torsional oscillation of shafts; vibration of strings, beams, membranes, and plates. Prerequisites: E.Mch. 13, Math. 44 or 431.  
*Mr. Vierck*
523. RELAXATION METHODS (3) Relaxation methods compared to iteration and other numerical methods of analysis; application to elasticity, plasticity, stability, fluid flow, heat transfer, and related fields. Prerequisites: E.Mch. 13 or 111, Math. 44.  
*Mr. Vierck*
524. MATHEMATICAL METHODS IN ENGINEERING (3-6) Prerequisite: Math. 451 or E.E. 435 or M.E. 452.  
*Mr. Davids*  
*Unit A* (3) Matrix and tensor analysis, finite differences, relaxation, perturbation, and other approximate methods in solution of various engineering problems.  
*Unit B* (3) Energy methods, potentials, application to torsion problems, nonlinear problems, analogies and dimensional analysis, Bessel and other special functions, harmonic analysis.
526. NONLINEAR MECHANICS (3) Integral curves, singular points, self-sustained oscillations, stability problems, Hill's and Van der Pol's equation, mechanical and electrical applications. Prerequisite: E.Mch. 522.
528. EXPERIMENTAL METHODS IN VIBRATIONS (3) Investigation of one or more degrees of freedom, free and forced mechanical vibrations, vibration properties of materials, vibration techniques in nondestructive testing. Prerequisite: E.Mch. 401 or 522.
529. ENGINEERING APPLICATIONS OF SONICS (3) Sound and ultrasound in engineering and science; principles, radiation, transducers, devices for sonic processing and testing. Prerequisite: Phys. 443.
530. SOLID STATE MECHANICS (3) Relation between solid state physics and mechanics; mechanical properties for static, fatigue, creep, and impact conditions; high temperature properties; applications. Prerequisite: E.Mch. 14. *Mr. Marin*
531. THEORY OF PLASTICITY AND APPLICATIONS (3) Yield condition; plastic stress-strain relations; theory of slip-line fields; applications to bending, torsion, axially symmetric bodies, metal processing. Prerequisite: E.Mch. 504 or 507.  
*Messrs. Hu and Marin*
533. DETERMINATION OF MECHANICAL PROPERTIES (3) Experimental methods for determining hardness, elastic constants, creep behavior, fatigue strength, plastic



## ENGINEERING MECHANICS

flow, and dynamic properties of metals. Prerequisite: E.Mch. 14 or 530.

*Mr. Hu*

534. PHOTOELASTICITY (3) Analysis of polariscopes; isoclinics, isochromatics, and stress trajectories; two- and three-dimensional photoelastic methods; determination of principal stresses; model preparation. Prerequisite: E.Mch. 408 or 507.

*Mr. Oppel*

540. MECHANICS OF CONTINUA (3) Unified mathematical treatment of elements of fluid mechanics and of elasticity and plasticity of solids. Prerequisite: Math. 44 or 431.

*Mr. Jaunzemis*

550. STUDIES IN ENGINEERING MECHANICS (1-6) Studies in any field of engineering mechanics.

## ENGLISH

PROFESSOR HENRY W. SAMS, *Head of the Department*  
246 Sparks Building

*Degrees Conferred:* Ph.D., D.Ed., M.A., M.Ed.

*Graduate Faculty:* Professors Bayard, Bowman, Condee, Cramer, Frank, Harris, Lewis, Locklin, Major, Peck, Rubin, Sams, Sutherland, and Young; Associate Professors Bauer, Bressler, Morse, and Reed; Assistant Professors Austin, Hansen, Jewkes, Meserole, Oldsey, Smith, and Weintraub.

A student may specialize in English literature, American literature, philology, or rhetoric. It is preferred that an entering student present 24 credits in English, but 18 credits in English exclusive of survey and freshman courses will be accepted. If the student does not present 18 credits in English, he must make up the deficiency early in his graduate work.

### ENGLISH (ENGL)

- |                                                       |                       |
|-------------------------------------------------------|-----------------------|
| 408. ADVANCED COLLEGE GRAMMAR (3)                     | <i>Miss McElwee</i>   |
| 412. THE WRITING OF FICTION (3-6)                     |                       |
| 422. MASTERS OF BRITISH LITERATURE (3-6)              |                       |
| 423. HISTORY OF BRITISH LITERATURE (3)                |                       |
| 432. MASTERS OF AMERICAN LITERATURE (3-6)             |                       |
| 433. HISTORY OF AMERICAN LITERATURE (3)               | <i>Mr. Sutherland</i> |
| 434. MOVEMENTS IN AMERICAN LITERATURE (3-6)           |                       |
| 437. AMERICAN POETRY (3)                              |                       |
| 438. AMERICAN DRAMA (3)                               | <i>Mr. Rubin</i>      |
| 445. CHAUCER (3)                                      |                       |
| 446. MILTON (3)                                       | <i>Mr. Condee</i>     |
| 447. BRITISH POETRY FROM SKELTON TO DRYDEN (3)        | <i>Miss Locklin</i>   |
| 448. ENGLISH DRAMA BEFORE SHAKESPEARE (3)             |                       |
| 449. SHAKESPEARE: THE CHRONICLE AND PROBLEM PLAYS (3) |                       |
| 451. PROSE AND POETRY OF 18TH CENTURY ENGLAND (3)     |                       |
| 455. THE NOVEL IN ENGLAND TO CHARLES DICKENS (3)      |                       |
| 458. THE DRAMA FROM DRYDEN TO SHERIDAN (3)            | <i>Mr. Harris</i>     |
| 461. BRITISH PROSE OF THE 19TH CENTURY (3)            |                       |
| 462. WORDSWORTH AND COLERIDGE (3)                     |                       |

## ENGLISH

463. BYRON, SHELLEY, AND KEATS (3)
465. VICTORIAN NOVEL (3)
466. THE AMERICAN NOVEL TO 1900 (3)
467. VICTORIAN POETRY (3)
475. MODERN BRITISH FICTION (3)
476. THE AMERICAN NOVEL SINCE 1900 (3)
477. BRITISH AND AMERICAN POETRY OF THE 20TH CENTURY (3)
478. BRITISH AND IRISH DRAMA SINCE 1890 (3)
481. HISTORY OF ENGLISH LITERARY CRITICISM (3) *Mr. Bressler*
488. MODERN CONTINENTAL DRAMA (3)
491. LITERATURE FOR TEACHERS IN SECONDARY SCHOOLS (3)
  
501. MATERIALS AND METHODS OF RESEARCH (3) Materials and techniques of research in English and American literary history; form and content of theses. Required of all graduate students with an English major.
521. OLD ENGLISH LANGUAGE (3) An introduction to the main features of the Old English language; readings in simple Old English prose and poetry.
522. OLD ENGLISH LITERATURE (3) A reading of the more important poetic works in Old English; some reading in translation.
540. STUDIES IN LITERATURE OF THE RENAISSANCE (3-6)
541. MEDIEVAL STUDIES (3) Seminar in special problems in medieval English literature.
542. MIDDLE ENGLISH LITERATURE (3) Introduction to Middle English and its dialects; study of the literature of the period exclusive of Chaucer.
543. STUDIES IN 17TH CENTURY LITERATURE (3-6) Poetry and prose of the middle years of the 17th century from the death of Shakespeare to 1660.
544. RESTORATION LITERATURE (3) Selected studies of writers in England between 1650 and 1700. *Mr. Harris*
545. CHAUCER (3) A critical study of the principal works of Chaucer; emphasis on literary backgrounds and exegesis.
548. SHAKESPEARE'S CONTEMPORARIES AND IMMEDIATE SUCCESSORS IN DRAMA (3) *Mr. Harris*
549. SHAKESPEARE (3) Special problems of sources, chronology, text, characterization, and motivation in the drama. *Mr. Bowman*
552. THE AGE OF SWIFT (3) Special studies varying from year to year. *Mr. Harris*
553. THE AGE OF JOHNSON (3) The work of Johnson and his circle.
554. STUDIES IN AMERICAN LITERATURE TO 1812 (3)
561. STUDIES IN THE ROMANTIC MOVEMENT (3-6)
562. STUDIES IN THE LITERATURE OF VICTORIAN ENGLAND (3-6)
564. STUDIES IN AMERICAN LITERATURE, 1812 TO 1900 (3) The major figures treated will vary from year to year.
573. STUDIES IN CONTEMPORARY LITERATURE (3-6)

574. STUDIES IN AMERICAN LITERATURE SINCE 1900 (3)
581. CONTEMPORARY LITERARY CRITICISM (3)
590. RESEARCH PROBLEMS IN ENGLISH (3-6) Methods of research in English, problems of bibliography, and method of evaluating sources and materials.
591. PROBLEMS IN AMERICAN LITERARY STUDY (3-6)
592. STUDIES IN AMERICAN LITERARY MYTH (3) An introduction to an interpretive, interdisciplinary study of some representative themes in American literature and culture.
593. ANGLO-AMERICAN FOLK SONG (3) Survey of relevant literary and ethnological scholarship and field work, European and American, from the early 16th century to the present.
595. STUDIES IN BRITISH FICTION (3) Mr. Bowman
596. STUDIES IN AMERICAN FICTION (3)
597. STUDIES IN AMERICAN POETRY (3)

## ENTOMOLOGY

BERTIL G. ANDERSON

*Head of the Department of Zoology and Entomology*  
212 Frear Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors E. J. Anderson, Blackburn, Cheng, Coon, and Frings; Associate Professor Rutschky; Assistant Professors Boyle and Smyth.

A student majoring in entomology may specialize in apiculture, ecology, economic entomology, morphology, physiology, insect resistances of plants, taxonomy, or toxicology of insecticides.

For admission a student is required to have 24 credits in entomology or zoology and related biological sciences; and he should have had chemistry through organic chemistry. Courses in physics and mathematics are also advantageous. A limited deficiency may be made up, without degree credit, while pursuing graduate work.

### ENTOMOLOGY (ENT)

401. MEDICAL AND VETERINARY ENTOMOLOGY (3) Mr. Frings
403. (Zool. 403). SYSTEMATICS (3) Mr. Boyle
405. INSECT MORPHOLOGY (3) Mr. Rutschky
413. ENTOMOLOGY SEMINAR (1 per semester)
429. PRINCIPLES OF INSECT CONTROL (3) Mr. Blackburn
431. ENTOMOLOGICAL PROBLEMS (1-6)
445. THE IDENTIFICATION OF INSECTS (3)
505. ADVANCED MORPHOLOGY OF INSECTS (3) Advanced work in either external or internal morphology of insects. Prerequisites: Ent. (Zool.) 403, Ent. 405. Spring semester, even years. Mr. Rutschky
506. IMMATURE INSECTS (3) The morphology and taxonomy of the immature stages of insects. Prerequisite: 9 credits in entomology. Spring semester, even years. Mr. Blackburn



## ENTOMOLOGY

508. THE BIOLOGICAL CONTROL OF INSECTS (2) Artificial use of bacteria, fungous diseases, and animals in control of injurious insects; methods and equipment for rearing parasites and predators on a large scale. Prerequisites: Ent. 6, 8.
509. ENTOMOLOGICAL TECHNIQUE (2) For advanced students dealing with special methods of collecting, rearing living insects, preparing and preserving immature stages, keeping records, and preparing illustrations for manuscript. Prerequisite: Ent. 6. Fall semester, odd years. *Mr. Coon*
514. ADVANCED SYSTEMATIC ENTOMOLOGY (1-15 per semester) Taxonomy of various orders of insects selected to meet the needs of the individual student. Prerequisites: Ent. (Zool.) 403, Ent. 405. *Mr. Boyle*
520. SPECIAL TOPICS (1-6)
528. INSECT PHYSIOLOGY (4) Normal functions of the insect body. Fall semester, even years. *Mr. Smyth*
531. INSECT TOXICOLOGY (2) General principles of toxicology and survey of the actions of substances toxic to insects. Spring semester, odd years. *Mr. Smyth*
540. INSECT RESISTANCE IN PLANTS (2) Mechanism, expression, permanence, and measurement of resistance to insects with special reference to farm crops. Spring semester, odd years. *Mr. Coon*

## FOODS AND NUTRITION

MIRIAM E. LOWENBERG, *Head of the Department*  
202A Home Economics Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., and M.Ed. in Foods and Nutrition; M.S. in Nutrition in Public Health (offered in co-operation with the University of Pittsburgh).

*Graduate Faculty:* Professors Dodds, Gordon, Lowenberg, and Pike; Associate Professors Fisher, Fuqua, and Olson.

Graduate programs in foods and nutrition prepare students for careers in high school teaching, college teaching, research, and adult program leadership. The program in nutrition in public health prepares the student for work in public health agencies.

For admission to a graduate program in foods or nutrition, a student must have completed at least 9 credits in organic and inorganic chemistry, 3 in biological chemistry, 3 in bacteriology, 3 in psychology, 9 in social sciences, and 10 in foods and nutrition.

For admission to the program in nutrition in public health, the requirements are at least 9 credits in inorganic chemistry, 3 in biological chemistry, 3 in bacteriology, 10 in social sciences, 7 in foods, and 4 in nutrition.

## FOODS, NUTRITION, AND HEALTH (F N)

400. SPECIAL PROBLEMS IN FOODS AND NUTRITION (1-3)
420. EXPERIMENTAL COOKERY (1-6)
421. ADVANCED FOODS (3)
422. SCIENTIFIC PRINCIPLES OF FOOD PREPARATION (3)
423. (H.M.F.E. 423). FAMILY FOOD PURCHASING (2)
425. FOOD PRESERVATION (2)

*Miss Olson*  
*Miss Batjer*

## FOODS AND NUTRITION

426. RECENT DEVELOPMENTS IN FOODS (3)  
452. ELEMENTS OF DIET IN DISEASE (3) *Miss Pike*  
455. TEACHING NUTRITION TO BOYS AND GIRLS (3)  
456. NUTRITION IN THE COMMUNITY (3) *Miss Lowenberg*  
457. PRINCIPLES OF NUTRITION (3)  
458. APPLIED NUTRITION (2)  
459. ADVANCED NUTRITION (3)  
490. FOODS AND NUTRITION SEMINAR (1)
520. READINGS IN FOODS (2) Critical review and reports of literature on selected food topics.
521. SEMINAR IN FOODS (1-6) Discussion and reports on current research in the foods field. Prerequisite or concurrent: F.N. 520.
522. ADVANCED EXPERIMENTAL FOODS (3) Experimental methods used in measuring the quality of foods; specific problems in food preparation.
530. PROBLEMS IN FOODS AND NUTRITION (1-6)
531. ADVANCES IN FOODS AND NUTRITION (3) Recent findings in the related areas of foods and nutrition.
550. READINGS IN NUTRITION (3) Readings and reports of selected topics in nutrition. Prerequisite: F.N. 457.
551. SEMINAR IN NUTRITION (1-6) Selected topics and recent advances in nutrition.
552. NUTRITION IN DISEASE (3) Physiological and biochemical problems in metabolic diseases and the nutritional aspects of therapy. *Miss Pike*
553. NUTRITION OF CHILDREN (3) Nutritional needs of the normal child during prenatal life, infancy, and childhood. Prerequisites: A.B.Ch. 35, F.N. 457.
555. FIELD WORK IN NUTRITION (2-4) Field problems planned to meet the needs of individual students. Hours and problems to be arranged.
556. THE SURVEY METHOD IN FOODS AND NUTRITION (2) Study of survey technique as a tool in the assay of food adequacy and nutritional status. *Miss Dodds*
557. INTERRELATIONSHIPS OF NUTRIENTS (2) Interrelationships of nutrients in the metabolic processes; their significance as applied to nutrition. *Miss Pike*

## FORESTRY

PETER W. FLETCHER  
*Director of the School of Forestry*  
102 Forestry Building

*Degrees Conferred:* M.S., M.F.

*Graduate Faculty:* Professors Chisman, Fletcher, Goddard, Humphrey, McDermott, Norton, Sharp, and White; Associate Professors Bartoo and Jorgensen.

A student may specialize in forest management, silviculture, wildlife management, wood utilization, wood technology, or forest products.

## FORESTRY

A B.S. degree in forestry normally provides the minimum preparation for specialization in any of the above areas except wood utilization. A B.S. degree in wood utilization, or a similar program emphasizing mathematics and basic engineering courses, provides the minimum preparation for specialization in wood utilization and is acceptable for advanced work in wood technology and forest products. Preparation for graduate work in wildlife management may be secured in any program which has emphasized land management and has included work in dendrology, silvics, forest measurement, and forest management.

Students with limited deficiencies may be admitted but must make up deficiencies without degree credit.

### FORESTRY (FOR)

- 421. REGIONAL SILVICULTURE (3)
- 427. FOREST RANGE MANAGEMENT (3)
- 445. IMPROVEMENTS (3)
- 450. ADVANCED MENSURATION (3)
- 455. FOREST PHOTO INTERPRETATION (3)
- 466. FOREST MANAGEMENT AND MANAGEMENT PLANS (3)
- 469. PROBLEMS IN FORESTRY (1-9)
- 480. POLICY AND ADMINISTRATION (3)
- 481. FOREST WATERSHED MANAGEMENT (3)
- 491. LOGGING AND LUMBERING (3)
- 497. SMALL SAWMILLS (3)
  
- 504. RESEARCH METHODS IN FORESTRY (2-6 per semester) Review of methods employed in conducting forestry research.
- 508. FOREST ECOLOGY (2-4) Organization, development, and classification of forest communities.
- 509. COVERT MANAGEMENT (2) Management of forest associations for maintenance and development of wildlife. Prerequisite: For. 508.
- 510. FORESTRY SEMINAR (1-2 per semester) Current problems of forest research presented as weekly seminar reports. May be repeated with additional credit for each semester's work.
- 550. FOREST MENSURATION (2-8 per semester) Research in some chosen field. Prerequisite: For. 450.
- 560. FOREST MANAGEMENT (3-8) Special topics in forest management and research in some chosen field. Prerequisite: For. 466.
- 575. APPLICATIONS OF FOREST ECONOMICS AND FINANCE (3 per semester) Survey of situations in forestry where business problems and particular circumstances of production, value, and costs are currently significant. Prerequisite: For. 70.
- 590. THE LUMBER INDUSTRY (2-4) Relation of the lumber industry to national economy and world trade; lumbermen's associations; lumber accounts.
- 591. PROBLEMS IN LOGGING AND LUMBERING (2-6) Research in some chosen phase of lumbering. Prerequisite or concurrent: For. 590.

### WOOD UTILIZATION (W U)

- 404. MECHANICAL PROPERTIES OF WOOD (3)
- 405. VENEER AND PLYWOOD (3)
- 431. PROBLEMS IN FOREST PRODUCTS (3-6)



- 435. SEASONING AND PRESERVATION (3)
- 437. ADVANCED WOOD TECHNOLOGY (3)
- 462. DEFECTS IN WOOD (3)
- 492. LUMBER DISTRIBUTION (3)
- 495. MILLING AND COSTS IN THE FOREST PRODUCTS INDUSTRIES (3)
  
- 502. WOOD FIBERS (3-5) Identification and physical and chemical characteristics of wood fibers used for pulp, either for paper or as a source of cellulose. Pulp quality, fiber measurements.
- 510. WOOD UTILIZATION SEMINAR (1-2 per semester)
- 530. PROBLEMS IN WOOD UTILIZATION (3-6 per semester) Prerequisite: W.U. 431.
- 531. STRUCTURAL USES OF WOOD AND WOOD PRODUCTS (3-6 per semester) Wood as a construction material; testing techniques for structural timbers and wood assemblies; use of laminated wood, ring connectors, and other types of special construction. Prerequisite: W.U. 404.
- 532. LAMINATES (3-6 per semester) Advanced and special studies in fabrication and use of plywood, laminated wood, paper-base laminates, and wood-to-metal bonding. Prerequisite: W.U. 405.
- 535. CONDITIONING TREATMENTS FOR WOOD (3-6 per semester) Advanced study and problems in preservative, seasoning, and other special treatments for wood and wood products. Prerequisite: W.U. 435.

## FUEL TECHNOLOGY

HOWARD B. PALMER, *Head of the Department*  
316 Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Palmer, Spicer, and Walker; Assistant Professors Polansky and Vastola.

The graduate program includes the chemistry, physics, and combustion processes of solid, liquid, and gaseous fuels, with research opportunities in all of these areas.

For admission, a bachelor's degree with undergraduate training is necessary in one of the following: chemistry, chemical engineering, mechanical engineering, physics, or fuel technology.

### FUEL TECHNOLOGY (F T)

- |                                                     |              |
|-----------------------------------------------------|--------------|
| 400. FUEL TECHNOLOGY RESEARCH AND DESIGN (1-3)      |              |
| 401. FUEL GASES AND GASIFICATION (2)                | Mr. Austin   |
| 402. CHEMICALS FROM FUELS (2)                       |              |
| 405. COMBUSTION CALCULATIONS (3)                    | Mr. Austin   |
| 406. GASEOUS COMBUSTION (3)                         | Mr. Palmer   |
| 408. COMBUSTION TECHNOLOGY (4)                      | Mr. Spicer   |
| 409. THERMAL PROCESSING OF FUELS (2)                | Mr. Polansky |
| 410. FUEL TECHNOLOGY LABORATORY (2)                 |              |
| 411. JET AND ROCKET FUELS (2)                       | Mr. Palmer   |
| 412. CATALYTIC PROCESSES IN THE FUEL INDUSTRIES (2) | Mr. Walker   |

## FUEL TECHNOLOGY

503. CHEMICAL CONSTITUTION AND SCIENTIFIC CLASSIFICATION OF COAL (3-6) Chemistry of plant constituents in relation to coal and the coalification process; constitution of coal as deduced by chemical methods; scientific classification of coals. Prerequisite: Chem. 31.
506. ADVANCED SOLIDS COMBUSTION (3) Current approaches to heterogeneous reactions in combustion and gasification of coals and carbons. Prerequisite: Chem. 461. Mr. Walker
507. ADVANCED THERMAL PROCESSING (3) Pyrolysis, coal carbonization, coke manufacture and uses; action of heat on coals and fuels; technical and economic factors. Prerequisites: Chem. 35, 461, or Mn.Pr. 410. Mr. Polansky
509. TECHNOLOGY OF TARS (3) Formation, constitution, physical and chemical properties of coal, oil-gas and water-gas tar; processing and utilization. Prerequisite: Chem. 31. Mr. Polansky
510. FUEL TECHNOLOGY PROBLEM (1-6 per semester) Special problems in fuel technology. Prerequisite: F.T. 503.
511. FUEL TECHNOLOGY SEMINAR (1-6) Selected topics from current fuel technology research examined and discussed. Prerequisite: Chem. 35 or 461.
512. ADVANCED GASEOUS COMBUSTION (3) Theories of reaction mechanisms; measurement of gaseous combustion parameters; review of current literature. Prerequisite: F.T. 406. Mr. Palmer

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in fuel technology studies are listed under Mineral Sciences in Part II of this bulletin.*

## GENETICS AND BREEDING

JAMES E. WRIGHT, *Chairman of the Committee on Genetics and Breeding*  
307 Buckhout Laboratory

*Degrees Conferred:* Ph.D., M.S.

Graduate programs are offered in the fields of theoretical and applied genetics. Courses in genetics and breeding are given by various departments. The basic and theoretical courses are listed under identical numbers in the Department of Botany and Plant Pathology and the Department of Zoology and Entomology. Courses dealing with genetic principles as applied to specific organisms are offered in the Departments of Agronomy, Animal Husbandry, Bacteriology, Horticulture, and Poultry Husbandry. The graduate committee for majors shall be appropriately represented by members of theoretical and applied phases who shall have the responsibility and jurisdiction for determining course work and research acceptable in satisfying degree requirements.

For entry as a major in this field no fewer than 15 credits in basic biology and 15 credits in the areas of chemistry, mathematics, and physics are required.

The following courses are available in genetics and breeding, and their descriptions may be found under the offerings of the several departments: Agro. 411, 509, 510, 582; A.H. 501, 505; Bact. 516; Bot. (Zool.) 405, 422, 505, 524, 528, 533; Hort. 444, 503, 519, 520; P.H. 402.

## GEOGRAPHY

E. WILLARD MILLER, *Head of the Department*  
202 Mineral Sciences Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Deasy and Miller; Associate Professors Griess, Rodgers, and Wernstedt.

Students may concentrate on physical geography, human geography, political geography, economic geography, cartography, or some aspect of regional geography.

Because physical geography is a branch of the physical sciences and human, political, and economic geography are branches of the social sciences, a student may enter graduate work under either of two options. Option 1, for the student who wishes to specialize in physical geography, requires the completion of 18 undergraduate credits in geography and 20 credits in mathematics and biological and physical sciences, including at least 6 credits in geology. Option 2, for the student who wishes to specialize in human, political, or economic geography, requires 18 undergraduate credits in geography plus 20 credits in the social sciences, including at least 3 in economics.

## GEOGRAPHY (GEOG)

- |                                                                                                                                                                                                                  |               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 400. REGIONAL GEOGRAPHY OF NORTH AMERICA (3)                                                                                                                                                                     | Mr. Deasy     |
| 405. GEOGRAPHY OF POPULATION AND SETTLEMENT (3)                                                                                                                                                                  | Mr. Simkins   |
| 420. URBAN GEOGRAPHY (3)                                                                                                                                                                                         | Mr. Rodgers   |
| 427. REGIONAL GEOGRAPHY OF THE SOVIET UNION (3)                                                                                                                                                                  | Mr. Rodgers   |
| 433. REGIONAL CLIMATOLOGY (3)                                                                                                                                                                                    | Mr. Wernstedt |
| 442. GEOGRAPHY OF EUROPE (3)                                                                                                                                                                                     | Mr. Miller    |
| 443. GEOGRAPHY OF THE ORIENT (3)                                                                                                                                                                                 | Mr. Wernstedt |
| 444. GEOGRAPHY OF AFRICA (3)                                                                                                                                                                                     | Mr. Smith     |
| 452. INTERPRETATION OF AERIAL PHOTOGRAPHS (3)                                                                                                                                                                    | Mr. Deasy     |
| 460. POLITICAL GEOGRAPHY (3)                                                                                                                                                                                     | Mr. Lewis     |
| 480. GEOGRAPHY OF WORLD MANUFACTURING (3)                                                                                                                                                                        | Mr. Miller    |
| 490. PHYSICAL GEOGRAPHY FOR TEACHERS (3)                                                                                                                                                                         | Mr. Lewis     |
| 503. ADVANCED REGIONAL GEOGRAPHY (3-12) Intensive study at an advanced level of selected regions or sections of the continents. Prerequisite: 12 credits in geography.                                           |               |
| 504. PHYSICAL GEOGRAPHY SEMINAR (3-12) The literature of some phase of physical geography with emphasis on procedures for organizing material for classroom reports and discussions.                             |               |
| 505. ECONOMIC GEOGRAPHY SEMINAR (3-12) The literature of some phase of economic geography with emphasis on procedures for organizing material for classroom reports and discussions.                             |               |
| 506. CULTURAL AND POLITICAL GEOGRAPHY SEMINAR (3-12) The literature of some phase of cultural and political geography with emphasis on procedures for organizing material for classroom reports and discussions. |               |
| 507. DEVELOPMENT OF GEOGRAPHIC THOUGHT (1-6) Critical analysis of the growth of geographic thought from antiquity to the present; emphasis on structure of modern geography.                                     |               |



## GEOGRAPHY

510. PHYSICAL GEOGRAPHY RESEARCH (3-10) Original study in physical geography: a field problem or detailed library investigation with analysis and presentation of data.
511. ECONOMIC GEOGRAPHY RESEARCH (3-10) Original study in economic geography: a field problem or detailed library investigation with analysis and presentation of data.
512. CULTURAL AND POLITICAL GEOGRAPHY RESEARCH (3-10) Original study in cultural and political geography: a field problem or detailed library investigation with analysis and presentation of data.

## GEOLOGY

FRANK M. SWARTZ, *Head of the Department*  
110 Mineral Sciences Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Krynine, Ridge, and Swartz; Associate Professors Lattman, Scholten, and Spackman; Assistant Professors Schmalz and Williams.

Graduate work in this field offers opportunity for specialization in stratigraphy, paleontology, paleobotany, palynology, regional and structural geology, geomorphology, coal geology, and metalliferous geology.

Prerequisites for admission include 25 credits in an approved combination of chemistry, physics, mathematics, and biological sciences, and at least 18 credits in geology and mineralogy.

### GEOLOGY (GEOL)

- |                                        |              |
|----------------------------------------|--------------|
| 400. GEOLOGY FOR TEACHERS (3)          |              |
| 420. PALEOBOTANY (3)                   | Mr. Spackman |
| 424. GEOLOGY OF COAL (2)               | Mr. Williams |
| 426. INTRODUCTORY PALYNOLOGY (2)       |              |
| 440. MARINE GEOLOGY (3)                | Mr. Schmalz  |
| 451. ECONOMIC GEOLOGY (3)              | Mr. Ridge    |
| 455. PHYSIOGRAPHY OF NORTH AMERICA (3) |              |
| 461. GEOLOGY OF THE UNITED STATES (3)  |              |
| 462. PRINCIPLES OF GEOMORPHOLOGY (3-6) | Mr. Lattman  |
| 464. PALEONTOLOGY (3)                  | Mr. Swartz   |
| 481. GEOLOGY OF OIL AND GAS (3)        | Mr. Scholten |
| 483. STRUCTURAL GEOLOGY (3)            |              |
| 484. PALEOZOIC STRATIGRAPHY (3)        | Mr. Swartz   |
| 486. STRATIGRAPHIC METHODS (1)         | Mr. Swartz   |

\*500. GEOLOGY SEMINAR (1-9) Presentation, at weekly departmental meetings, of topics selected from geological literature.

†501. STRATIGRAPHY (3-12) Principles of stratigraphic classification, lithofacies and biofacies, faunal zonation, correlation, sedimentation, and paleogeography, illustrated by stratigraphy of classical geologic regions: (a) Pre-Cambrian; (b) Paleozoic; (c) Mesozoic; (d) Cenozoic. Prerequisite: Geol. 464. Mr. Swartz

\*Credits to be arranged, 1 to 6 per semester.

†Credits to be arranged, 3 to 6 per semester.

- †503. PALEONTOLOGY (3-9) Morphology of animal groups significant for their fossils; nature of species and faunal zones. Seminars may be arranged for studies of special fossil groups, microfossils, paleoecology. *Mr. Swartz*
504. HISTORY OF GEOLOGY (2-3) Development through the ages of the scientific method in earth sciences. Fall semester, odd years. *Mr. Krynine*
507. SEMINAR IN GEOMORPHOLOGY (3-6) Classic and current literature in geomorphology. *Mr. Lattman*
511. ORE DEPOSITS: PRINCIPLES (3-6) Geological and geochemical processes controlling ore deposition; genetic classification of ore deposits. Prerequisite: Geol. 451. *Mr. Ridge*
512. ORE DEPOSITS: TYPES (1-6) Geologic history and field examination of selected ore bodies; forming media; causes, sequences, and loci of emplacement; wall rock alteration; secondary enrichment. Prerequisite: Geol. 511. *Mr. Ridge*
515. ORE MICROSCOPY (2-3) Theory and use of the ore microscope in identifying ore minerals in polished section, establishing paragenetic sequences, determining manner of deposition.
520. SEMINAR IN PALEOBOTANY (2-6) Current and classic literature concerning evolution, paleoecology, and geologic history of vascular plants. *Mr. Spackman*
524. COAL PETROLOGY (1-6) Microscopy, source materials, coalification, constitution, classification of peats, lignites, bituminous coal, anthracite. *Mr. Spackman*
526. PROBLEMS IN PALYNOLOGY (3-9) Systematics; paleoecological palynology; Paleozoic palynology; Mesozoic and Cenozoic palynology; Pleistocene vegetational history.
530. GEOLOGICAL PROBLEMS (3-6) Study, from the literature, of a selected geological problem. Prerequisite: 10 credits in geology and mineralogy.
540. CHEMICAL OCEANOGRAPHY (3) Chemical reactions in sea water and at the sea floor related to sedimentation and diagenesis. *Mr. Schmalz*
545. GLACIAL GEOLOGY (3) Glaciers: their characteristics, causes, deposits, land forms, effects in periglacial regions. *Mr. Lattman*
546. PRINCIPLES OF PHOTOGEOLOGY (3) Use of aerial photographs and mosaics in structural, geomorphic, and rock distribution studies and in compilation of maps. Prerequisites: Geol. 462, 483. *Mr. Lattman*
551. GEOTECTONICS (3-16) Tectonic principles and elements: nature and development of geosynclines, island arcs, mountain structures, stable masses, cratons, mobile belts. *Mr. Scholten*
555. ADVANCED STRUCTURE AND PETROFABRICS (1-3) Macroscopic and microscopic recognition, measurement, and interpretation of small-scale rock structures and mineral orientation patterns in deformed rocks.
571. PETROLEUM PROVINCES OF THE WORLD (3) Stratigraphy, structure, geologic history, and oil and gas occurrence in major petroliferous provinces. *Mr. Scholten*
590. GEOLOGY FIELD TRIP (1 per year) Field study of regional geologic features with trips in successive years to differing geologic provinces. Required each spring of all graduate students in geology.

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in geological studies are listed under Mineral Sciences in Part II of this bulletin.

† Credits to be arranged, 3 to 6 per semester.

## G E O P H Y S I C S   a n d   G E O C H E M I S T R Y

B. F. HOWELL, JR., *Head of the Department*  
220 Mineral Sciences Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Bell, Greig, Howell, Keith, Osborn, Roy, and Tuttle; Associate Professor Burnham; Assistant Professors Barnes, Crowe, and Herzog; Mrs. Roy.

Graduate work is offered in the field of geophysics (geophysical prospecting, seismology, gravity, well logging, radioactive age determinations, tectonics, physical properties of rocks) and in the field of geochemistry (crystal chemistry, phase equilibria, element distribution and affiliations, isotope geochemistry, geochemical prospecting, cosmochemistry, high-temperature and high-pressure geochemistry).

Before starting graduate study an applicant is generally expected to have had (1) a standard introductory course in each of the following four subjects: chemistry, physics, geology, and mineralogy; (2) 12 semester hours of intermediate level work in any one or a combination of chemistry, physics, and geological science; and (3) mathematics through integral calculus (for geochemistry) or differential equations (for geophysics). Students who have taken somewhat less than the indicated minima in these subjects may be admitted, but must make up their deficiencies concurrently with their graduate studies.

### G E O P H Y S I C S   A N D   G E O C H E M I S T R Y   ( G   G )

- |                                                                                                                                                                         |                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| 401. ELECTRICAL PROSPECTING (3)                                                                                                                                         | Mr. Crowe                |
| 402. SEISMIC PROSPECTING (3)                                                                                                                                            | Mr. Howell               |
| 403. GEOPHYSICS FIELD WORK (1-3)                                                                                                                                        | Messrs. Crowe and Howell |
| 405. INTRODUCTORY GEOPHYSICS (3)                                                                                                                                        | Mr. Howell               |
| 406. INTRODUCTORY GEOCHEMISTRY (3)                                                                                                                                      | Mr. Keith                |
| 407. WELL LOGGING (3)                                                                                                                                                   | Mr. Crowe                |
| 408. POTENTIAL THEORY APPLIED TO EARTH PROBLEMS (3)                                                                                                                     | Mr. Crowe                |
| 409. GEOPHYSICAL PROSPECTING (3)                                                                                                                                        | Mr. Crowe                |
| 500. GEOPHYSICAL SEMINAR (1 per semester) Discussion of geophysical reports and papers; scientific outlook.                                                             |                          |
| 501. RESEARCH (1-15 per semester) Original research in geophysics or geochemistry.                                                                                      |                          |
| 502. SEISMIC INSTRUMENTS (3) Characteristics and design of seismometers and seismic recorders. Prerequisites: Phys. 285, differential equations. Given alternate years. |                          |
| 503. SPECIAL STUDIES IN GEOPHYSICS (1-9) Special studies of the theories of geophysical methods.                                                                        |                          |
| 507. SEISMOLOGY (3) Nature and transmission of seismic waves; cause and occurrence of earthquakes; applications in seismic prospecting.                                 |                          |
| 508. TECTONICS (3) Seminar in the cause and nature of the principal deformations of the earth.                                                                          |                          |
| 509. GEOCHEMISTRY SEMINAR (1 per semester)                                                                                                                              |                          |



## G E O P H Y S I C S   A N D   G E O C H E M I S T R Y

510. PROBLEMS IN GEOCHEMISTRY (1-9) Laboratory and library study of special problems.
512. INTRODUCTION TO HIGH-TEMPERATURE GEOCHEMISTRY (3) Ion configuration and radii; simple crystal structures; measurement and control of temperature and pressure; methods and principles of phase equilibrium determination.  
*Messrs. Roy and Osborn*
513. PHASE EQUILIBRIA IN MINERAL SYSTEMS (3-6) Phase relations and constitution of inorganic crystals and liquids; special emphasis on systems closely related to natural magmas and rock systems. Prerequisite: G.G. 512.  
*Messrs. Osborn, Tuttle, and Roy*
514. ELEMENT DISTRIBUTION IN THE EARTH (3) Principles and data from studies of phase equilibria, petrology, and crystal structure as related to distribution of elements in minerals, rocks, and the earth.  
*Mr. Burnham*
515. ELECTRIC WELL-LOGGING (2-3) Quantitative and qualitative methods of interpreting electric resistivity, induction, and self-potential logs; comparison of electrical logging methods.
516. INTRODUCTION TO NUCLEAR PROCESSES IN GEOLOGIC SETTINGS (2) Natural radioactivity and its measurement, interpretation, and use in research and exploration.  
*Mr. Herzog*
517. AGE DETERMINATIONS (1-2) Geochemistry of radioactive elements and their daughters; age determination techniques and observations.  
*Mr. Herzog*
518. ISOTOPE-RATIO VARIATIONS IN NATURE (2) Theoretical basis and observations of isotope fractionation in nature: paleotemperature scale; temperatures of formation of ore deposits and other rocks.
519. COSMOCHEMISTRY AND NUCLEOGENESIS (2) Distribution and composition of matter; origin of solar system and earth, of constituent nuclides, of life.  
*Mr. Herzog*

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in geophysical and geochemical studies are listed under Mineral Sciences in Part II of this bulletin.*

## G E R M A N

PHILIP A. SHELLEY, *Head of the Department*  
229 Sparks Building

*Degrees Conferred:* Ph.D., M.A., M.Ed.

*Graduate Faculty:* Professors Adolf, Buffington, and Shelley; Associate Professors de Levie and Striedieck; Assistant Professor Browne.

There is opportunity for major emphasis upon either literature or philology. Minimum qualifications for admission include 18 undergraduate credits in German; provision is made, however, for admission with limited deficiencies.

### G E R M A N (G E R)

400. PROSEMINAR IN BIBLIOGRAPHY AND METHODS OF RESEARCH (2) *Mr. Shelley*

## GERMAN

401. HISTORY OF THE GERMAN LANGUAGE (3) Mr. Buffington  
 402. MIDDLE HIGH GERMAN (3) Mr. Buffington  
 420. GERMAN LITERATURE TO 1700 (3) Miss Adolf  
 421. GERMAN LITERATURE IN THE 18TH CENTURY (3) Messrs. Buffington and de Levie  
 422. GERMAN LITERATURE IN THE 19TH CENTURY (3) Miss Adolf  
 423. GERMAN LITERATURE OF THE 20TH CENTURY (3)  
 424. GOETHE'S LIFE AND WORKS (3) Messrs. Buffington and de Levie  
 426. SCHILLER'S LIFE AND WORKS (3)  
 443. (C.Lit. 443). LITERARY RELATIONS OF GERMANY WITH ENGLAND AND AMERICA (3-9) Mr. Shelley
- \*1G. ELEMENTARY GERMAN FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.
- \*2G. ELEMENTARY GERMAN FOR GRADUATE STUDENTS (3) Continuation of Ger. 1G, with opportunity for reading in special fields.
501. GERMAN LANGUAGE SEMINAR (3-12) Critical study of special problems in the Germanic languages, with emphasis on Gothic and the High German dialects in different eras.
515. GERMAN LITERATURE SEMINAR (3-12) Special aspects and characteristics of individual writers and various types and periods of literature.
531. SPECIAL STUDIES IN THE GERMAN LYRIC (3) Mr. Shelley  
 532. SPECIAL STUDIES IN THE GERMAN DRAMA (3) Miss Adolf  
 533. SPECIAL STUDIES IN THE GERMAN SHORT STORY (3)  
 534. SPECIAL STUDIES IN THE GERMAN NOVEL (3) Miss Adolf  
 552. OLD HIGH GERMAN (3) Essentials of the grammar, with special treatment of the High German sound shift and of ablaut and umlaut. Reading of works written before 1100 A.D. Mr. Buffington  
 553. GOTHIC (3) Essentials of the grammar; reading of Ulfilas' Bible translation. Suitable also for advanced students in English. Miss Adolf

## HIGHER EDUCATION

HUGH S. BROWN, *in Charge of Graduate Programs in Higher Education*  
 212 Willard Building

*Degree Conferred:* D.Ed.

*Graduate Faculty:* Professors Brown, Patrick, and Wellington.

Graduate students with any undergraduate major may enter the program without other prerequisites. The following courses in higher education are listed under the offerings of the Department of Educational Services: Ed.Ser. 545 to 552 inclusive and 555 (See page 87). To complete a program to meet the student's needs, additional courses will be selected from other departments of the University.

Candidates for advanced degrees in other fields may elect higher education as a minor, subject to the restrictions concerning minors.

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\*No graduate credit is given for this course.

## HISTORY

ROBERT K. MURRAY, *Head of the Department*  
116 Sparks Building

*Degrees Conferred:* Ph.D., D.Ed., M.A., M.Ed.

*Graduate Faculty:* Professors Brown, Dahmus, Forster, Gray, Klein, Murray, Pundt, and Rayback; Associate Professors DeNovo, Green, McNall, and Thaden; Assistant Professors Hassler, Pixton, and Spence.

Graduate work is offered in the following fields of history: ancient, medieval, early modern European, modern European, colonial American, 19th century American, modern American, British, Russian, Latin American, Far Eastern, political (European or American), economic (European or American); diplomatic (European or American), social and cultural (European or American).

For a master's degree the candidate must pass examinations in two of the first seven of the above fields. A candidate for a master's degree must also take work in a cognate field. For the doctorate, a candidate must pass examinations in four of the above fields, one of which must be his thesis field. He also must pass an examination either in another of the above history fields and a single cognate field, or in a study area made up of a number of academic disciplines related to his thesis field.

The entering student should present evidence of undergraduate course work covering the history of Europe from ancient times to the present and the history of America from its discovery to the present.

## HISTORY (HIST)

- |                                                                         |                           |
|-------------------------------------------------------------------------|---------------------------|
| 401. ANCIENT CIVILIZATION (3)                                           |                           |
| 403. THE MIDDLE AGES FROM CONSTANTINE TO THE CRUSADES (3)               | Mr. Dahmus                |
| 404. THE MIDDLE AGES FROM THE CRUSADES TO THE RENAISSANCE (3)           | Mr. Dahmus                |
| 408. INTELLECTUAL HISTORY OF THE MIDDLE AGES (2-3)                      | Mr. Dahmus                |
| 410. RENAISSANCE AND REFORMATION (3)                                    | Mr. Green                 |
| 413. THE AGE OF ABSOLUTISM (3)                                          | Mr. Green                 |
| 417. NINETEENTH CENTURY EUROPE (3)                                      | Mr. Forster               |
| 419. RECENT EUROPEAN HISTORY (3)                                        | Mr. Forster               |
| 422. HISTORY OF THE AMERICAN FRONTIER (3)                               | Mr. Spence                |
| 425. HISTORICAL BACKGROUND OF AMERICAN POLITICAL PARTIES, 1607-1900 (3) | Mr. Rayback               |
| 427. THE DIPLOMATIC HISTORY OF THE UNITED STATES (3)                    | Mr. DeNovo                |
| 428. AMERICAN MILITARY HISTORY (3)                                      | Mr. Hassler               |
| 431. COLONIAL AND REVOLUTIONARY AMERICA (3)                             | Mr. Hoogenboom            |
| 432. THE FORMATIVE PERIOD OF AMERICAN HISTORY (3)                       | Mr. Klein                 |
| 433. THE MIDDLE PERIOD OF AMERICAN HISTORY (3)                          | Mr. Klein                 |
| 434. THE UNITED STATES IN CIVIL WAR AND RECONSTRUCTION (3)              | Mr. Hassler               |
| 435. THE EMERGENCE OF MODERN AMERICA (3)                                | Messrs. Murray and Spence |
| 436. RECENT AMERICAN HISTORY (3)                                        | Mr. Murray                |
| 440. HISTORY OF ENGLAND AND GREAT BRITAIN SINCE 1485 (3)                | Mr. Ralls                 |
| 442. HISTORY OF RUSSIA TO 1861 (3)                                      | Mr. Thaden                |
| 443. HISTORY OF MODERN RUSSIA (3)                                       | Mr. Thaden                |
| 444. EASTERN EUROPE IN MODERN TIMES (3)                                 | Mr. Thaden                |
| 447. SOCIAL AND ECONOMIC HISTORY OF EUROPE SINCE 1750 (3)               | Mr. Pundt                 |
| 448. INTELLECTUAL AND CULTURAL HISTORY OF MODERN EUROPE (3)             |                           |
| 452. SOCIAL AND CULTURAL HISTORY OF THE UNITED STATES SINCE 1783 (3)    | Mr. Brown                 |
| 454. ECONOMIC DEVELOPMENT OF THE UNITED STATES (3)                      | Mr. McNall                |



## HISTORY

- |                                                       |                              |
|-------------------------------------------------------|------------------------------|
| 456. HISTORY OF AMERICAN LABOR (3)                    | Mr. Rayback                  |
| 460. LATIN AMERICA AND THE UNITED STATES (3)          | Mr. Gray                     |
| 461. SOCIAL AND CULTURAL HISTORY OF LATIN AMERICA (3) | Mr. Gray                     |
| 471. HISTORY OF MODERN CHINA (3)                      |                              |
| 481. THE MIDDLE EAST IN MODERN TIMES (3)              | Mr. DeNovo                   |
| 499. FOREIGN STUDY IN HISTORY (2-6)                   |                              |
| 501. EUROPEAN HISTORIOGRAPHY (3)                      | Mr. Pundt                    |
| 502. AMERICAN HISTORIOGRAPHY (3)                      | Mr. Klein                    |
| 504. MEDIEVAL CIVILIZATION (3-9)                      | Mr. Dahmus                   |
| 505. THE AGE OF THE REFORMATION (3-6)                 | Mr. Green                    |
| 508. STUDIES IN EUROPEAN HISTORY, 1600-1789 (3-6)     | Mr. Pundt                    |
| 509. EUROPE SINCE 1789 (3-6)                          | Mr. Forster                  |
| 512. STUDIES IN PENNSYLVANIA HISTORY (3-6)            | Mr. Klein                    |
| 520. COLONIAL AND REVOLUTIONARY AMERICA (3-6)         | Mr. Hoogenboom               |
| 533. THE UNITED STATES, 1783-1860 (3-6)               | Mr. Klein                    |
| 534. THE UNITED STATES, 1860-1900 (3-6)               | Mr. Brown                    |
| 536. THE UNITED STATES IN THE 20TH CENTURY (3-6)      | Mr. Murray                   |
| 538. DIPLOMATIC HISTORY OF THE UNITED STATES (3)      | Messrs. Gray and DeNovo      |
| 539. ECONOMIC HISTORY OF THE UNITED STATES (3)        | Mr. McNall                   |
| 540. STUDIES IN BRITISH HISTORY (3-6)                 |                              |
| 545. STUDIES IN RUSSIAN AND SLAVIC HISTORY (3-6)      | Mr. Thaden                   |
| 550. PROBLEMS IN HISTORY (3-6)                        |                              |
| 562. SEMINAR IN LATIN-AMERICAN HISTORY (3-6)          | Mr. Gray                     |
| 563. STUDIES IN THE HISTORY OF THE CARIBBEAN AREA (3) | Prerequisites: Hist. 22, 23. |
|                                                       | Mr. Gray                     |
| 599. READINGS IN HISTORY (3)                          |                              |

## HOME ART

JAMES E. MONTGOMERY, *Professor of Housing and Home Art*  
38B Home Economics South

No advanced degree is offered in this field, but a candidate with a major in another field may choose a minor in home art upon approval by his major department.

### HOME ART (H ART)

- 400. SPECIAL PROBLEMS IN HOME FURNISHINGS (3)
- 433. ADVANCED HOME CRAFTS (2-12)
- 440. HOME FURNISHING PROBLEMS (3)
- 447. HOME FURNISHINGS FOR THE FAMILY (3)

515. **BACKGROUNDS OF THE HOME ARTS (3)** Evaluation of useful objects in respect to their form, function, and time; selections for exhibition. Prerequisites: H.Art 216 or Art 15 or A.Ed. 6, and A.A.H. 1 or H.Art 240.
530. **PROBLEMS IN HOME ART (1-6)** Individual investigation, analysis, and presentation. Prerequisite: 6 credits in home art, art education, or art.
541. **ART IN THE ENVIRONMENT (3)** Approach based upon human needs with consideration of materials in the light of their use in home living. Prerequisite: Art 14 or A.Ed. 5 or H.Art 440.

## HOME ECONOMICS EDUCATION

MARJORIE EAST, *Head of the Department*  
116B Home Economics Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors East and Hatcher; Associate Professor Ray.

Research and graduate courses may be chosen to give emphasis to special areas of interest in home economics education, such as curriculum development; evaluation; teaching at the elementary, secondary, adult, or higher education levels; supervision; administration in colleges; or research.

For admission the student must present approximately 50 semester hours of undergraduate work from the following areas: home economics education, education and/or psychology, aspects of home economics; the physical and biological sciences; and the social sciences.

### HOME ECONOMICS EDUCATION (HE ED)

- 406, 406v. **TEACHING AIDS IN FAMILY LIFE EDUCATION (1-4)**
- 427, 427v. **FAMILY LIFE EDUCATION (3)**
- 443, 443v. **ADULT HOMEMAKING EDUCATION (3)**
- 463, 463v. **SENIOR SEMINAR (1)**
- \*466, 466v. **STUDENT TEACHING (9)**
- 478, 478v. **APPRAISING STUDENT PROGRESS IN EDUCATION FOR FAMILY LIVING (3)**
- 479, 479v. **READINGS IN HOME ECONOMICS EDUCATION (1-4)**
- 502, 502v. **HOME ECONOMICS INSTRUCTION AT THE COLLEGE LEVEL (3)** Teaching techniques suitable for college instruction in home economics; for prospective home economics college teachers. *Mrs. East*
- 503, 503v. **PROBLEMS IN HOME ECONOMICS TEACHER EDUCATION (3)** Organization of college programs of teacher education; use of resources; records; field services; recruitment and selection of personnel. Prerequisite: at least two years of experience in teaching home economics. *Miss Hatcher*
- 504, 504v. **CURRENT DEVELOPMENTS IN EDUCATION IN RELATION TO HOME ECONOMICS (3)** Opportunity for home economists to study newer developments in education. Prerequisite: one year of teaching experience in home economics.

*Mrs. East*

\*A grade point average of 2.2 in all previous work is prerequisite to each course in student teaching.

## HOME ECONOMICS EDUCATION

- 505, 505v. PRACTICUM IN TEACHING HOME ECONOMICS IN THE SECONDARY SCHOOL (3-6) Projects in home economics education which may be carried out in the school in which the teacher is regularly employed.
- 509, 509v. CURRICULUM WORKSHOP IN FAMILY LIFE EDUCATION (3) Laboratory course in problems of curriculum building; individual problems in this field; frequent individual and group conferences. Prerequisite: one year's experience in teaching home economics. *Mrs. East or Miss Hatcher*
- 510, 510v. THE SUPERVISION OF HOME ECONOMICS TEACHING (2-6) For teachers of home economics desiring to qualify as city, county, or student teacher supervisors. Prerequisite: graduation from a four-year teacher education curriculum and two years' teaching experience in home economics. *Mrs. East*
- 518, 518v. EVALUATION IN FAMILY LIFE EDUCATION (3) Methods of evaluating progress toward goals in home economics education and use of findings in program planning and revision. *Miss Hatcher*
- 521, 521v. HOME ECONOMICS EDUCATION SEMINAR (2-3) Selected topics and recent developments in education for family living. Conferences and guidance relative to individual research problems.
- 526, 526v. THE COMMUNITY PROGRAM IN FAMILY LIFE EDUCATION (2-3) Ways of discovering community needs and resources; methods of developing the community program in family living; leadership education for the lay member of the community.
- 530, 530v. PROBLEMS IN HOME ECONOMICS EDUCATION (1-6 per semester) Individual investigation of problems related to the teaching, supervision, or administration of home economics education.

## HOME ECONOMICS, GENERAL

DOROTHY HOUGHTON, *Professor of Home Economics*  
109 Home Economics Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

The program in General Home Economics is planned for teachers in secondary schools or small colleges and others who wish to be proficient in several areas of home economics. Consequently, the student must have a strong home economics background for admission to the major.

The major for the M.S. or M.Ed. degree consists of a minimum of 6 credits in each of three areas of home economics. Three areas of home economics are also the basis for the major at the doctoral level. However, the minimum credit requirements in each area are established after consultation with a committee which reviews all previous work. The student chooses a minor field of basic education or one of the applied fields, such as home economics education, secondary education, or higher education.

### GENERAL HOME ECONOMICS (G H E)

- 516, 516v. METHODS OF RESEARCH IN HOME ECONOMICS (3) Review of problems and techniques of research in home economics. Required of all graduate students in home economics. *Miss Ray and Mrs. Siegel*
530. SELECTED PROBLEMS IN GENERAL HOME ECONOMICS (1-6)



## HOME MANAGEMENT AND FAMILY ECONOMICS

DELPHA E. WIESENDANGER

*Head of the Department of Home Management, Housing, and Home Art*  
271 Home Economics South*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.*Graduate Faculty:* Professors Allgood, Britton, Montgomery, Ruef, and Wiesendanger.

In the graduate program family management practices, their effects upon members of the family unit, and the interaction of such practices with the local and national economy are studied in relation to principles of economics, philosophy, psychology, sociology, and political science.

Those interested in emphasizing a study of home management, family economics, family housing, and home equipment may do so through this major. There are no specific course requirements for admission.

## HOUSING AND HOME EQUIPMENT (HS EQ)

413. HOME EQUIPMENT (3)

470. HOUSING THE FAMILY (2-3)

## HOME MANAGEMENT AND FAMILY ECONOMICS (HM FE)

415. HOUSEHOLD BUYING PRACTICES (3)

419. MANAGING FAMILY FINANCIAL RESOURCES (3)

423. (F.N. 423). FAMILY FOOD PURCHASING (2)

424. ECONOMIC CONDITIONS IN RELATION TO THE FAMILY (3)

*Miss Britton*

439. MANAGEMENT PRINCIPLES IN HOME OPERATION (2)

*Miss Chennault*

442. RESIDENT EXPERIENCE IN HOME MANAGEMENT (3) Room and board will be charged at regular rates.

*Miss Chennault*

445. HOME MANAGEMENT EXPERIENCE (3)

477. FAMILY MANAGEMENT (3)

500. NONTHESIS RESEARCH (1-6) Nonthesis research problems.

515. CONSUMER PROBLEMS (2-3) Methods of securing, evaluating, and presenting data concerning household commodities. For home economics teachers in high schools, colleges, and adult classes. Prerequisites: F.N. 220, H.M.F.E. 442.

*Miss Britton*

524. ECONOMIC PROBLEMS OF THE HOUSEHOLD (3) Economic problems of the present-day family; special emphasis on factors in household production, use of money income, and standards of living. Prerequisites: H.M.F.E. 439, Econ. 14.

*Miss Britton*

528. HOME MANAGEMENT SUPERVISION (2-3) Evaluation of objectives and techniques in organization, supervision, and teaching of the home management house experience. Prerequisite: H.M.F.E. 439.

543. HOME MANAGEMENT IN RELATION TO FAMILY LIVING (3) Includes work with families in solution of their management problems. Prerequisites: F.N. 220, H.M.F.E. 439.

*Miss Wiesendanger*

544. PROBLEMS IN HOME MANAGEMENT AND FAMILY ECONOMICS (1-6) Investigation of selected problems in home management and family economics. Prerequisite: 6 credits of home management or family economics courses in home economics.

550. SEMINAR IN HOME MANAGEMENT AND FAMILY ECONOMICS (1-6) Discussion and reports on developments in home management and family economics.

## HORTICULTURE

RUSSELL E. LARSON, *Head of the Department*  
102 Tyson Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Fleming, Hitz, Larson, Mastalerz, Meahl, and Odland; Associate Professors McArdle, Ritter, Smith, Tukey, and Walker; Assistant Professors Bergman and Pfahl.

Students may specialize in propagation, production, processing, breeding, nutrition, and other physiological studies of horticultural crop species, and in landscape design.

Prerequisites for major work in horticulture vary according to area of specialization; but basic courses in chemistry, mathematics, and the biological sciences are required. In addition, for students who wish to specialize in landscape architecture, basic courses in art and architecture and at least 30 credits in landscape architecture are required. Students who lack prerequisite courses may be admitted but are required to fulfill deficiencies without degree credit.

## HORTICULTURE (HORT)

- |                                                                                                                                                                                       |               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 412. STORAGE OF HORTICULTURAL CROPS (3)                                                                                                                                               | Mr. Ritter    |
| 418. SUBTROPICAL AND TROPICAL FRUITS (3)                                                                                                                                              |               |
| 424. ADVANCED OLERICULTURE (3-6)                                                                                                                                                      | Mr. Odland    |
| 425. ADVANCED FRUIT AND VEGETABLE PROCESSING I (3)                                                                                                                                    | Mr. McArdle   |
| 426. ADVANCED FRUIT AND VEGETABLE PROCESSING II (3)                                                                                                                                   | Mr. McArdle   |
| 427. ADVANCED FLORICULTURE (3)                                                                                                                                                        | Mr. White     |
| 428. ADVANCED FLORICULTURE (3)                                                                                                                                                        | Mr. Mastalerz |
| 444. ADVANCED PLANT BREEDING (3-6)                                                                                                                                                    | Mr. Walker    |
| 446. ADVANCED POMOLOGY (3)                                                                                                                                                            |               |
| 447. PROBLEMS IN HORTICULTURE (1-9)                                                                                                                                                   |               |
| 453. NURSERY PRINCIPLES AND PRACTICE (3)                                                                                                                                              | Mr. Meahl     |
| 456. PROBLEMS IN NURSERY PRACTICE (3)                                                                                                                                                 | Mr. Meahl     |
|                                                                                                                                                                                       |               |
| 500. ECOLOGY OF FRUIT PLANTS (3) Factors limiting the distribution and intensity of culture of fruit species and varieties and effect of environmental factors on cultural practices. | Mr. Tukey     |
|                                                                                                                                                                                       |               |
| 501. EXPERIMENTAL PROBLEMS IN POMOLOGY (2-12) Investigation of problems involving review of literature, field and laboratory research.                                                |               |
|                                                                                                                                                                                       |               |
| 503. EXPERIMENTAL PLANT BREEDING (2-12) Problems based mainly on research work of the department, with review of experimental methods and literature. Prerequisite: Hort. 444.        | Mr. Larson    |
|                                                                                                                                                                                       |               |
| 504. EXPERIMENTAL PROBLEMS IN OLERICULTURE (2-9) Investigation of problems involving review of literature, field and laboratory research. Prerequisite: Hort. 424.                    | Mr. Odland    |
|                                                                                                                                                                                       |               |
| 505. PROBLEMS IN VEGETABLE PRODUCTION (2-6) Methods used in the more valuable contributions to vegetable production. Prerequisite: Hort. 424.                                         | Mr. Odland    |
|                                                                                                                                                                                       |               |
| 506. NUTRITION OF HORTICULTURAL CROPS (2-4) Principles, applications, and interpretations of diagnostic methods for determining fertilizer requirements of horticultural crops.       | Mr. Smith     |

## HORTICULTURE

512. **PRINCIPLES OF FRUIT AND VEGETABLE STORAGE (2-4)** Principles involved in the maturation, storage, and senescence of fruits and vegetables, and their application. *Mr. Ritter*
513. **EXPERIMENTAL PROBLEMS IN ORNAMENTAL HORTICULTURE (2-12)** Review of research in ornamental horticulture, with original investigations. *Mr. Meahl*
514. **PROPAGATION OF ORNAMENTAL AND FRUIT PLANTS (3)** Factors affecting the asexual and sexual propagation of fruit and ornamental plants. *Mr. Meahl*
517. **HORTICULTURE SEMINAR (1 per semester)** Review of current research publications in horticulture. Each student presents one or more reviews of assigned topics.
519. **SEMINAR ON THE GENETICS OF HORTICULTURAL CROPS (1 per semester)** Review of current research publications on the genetics of horticultural crops. Each student presents one or more reviews of literature on assigned topics.
520. **SEMINAR ON THE BREEDING OF HORTICULTURAL CROPS (1 per semester)** Each student presents one or more reviews of literature on assigned topics.
523. **PROPAGATION AND IMPROVEMENT OF VEGETABLE AND FLOWER CROPS (3)** Methods and special techniques in breeding of flowers and vegetables; maintenance of seed stocks and seed production. Prerequisite: Hort. 444. *Mr. Odland*
524. **EXPERIMENTAL PROCEDURES IN HORTICULTURAL RESEARCH (3)** *Mr. Larson*
525. **HORTICULTURAL RESEARCH TECHNIQUES (3)** Practice in and comparison of methods and apparatus used in horticultural research. *Mr. Hitz*
526. **EXPERIMENTAL PROBLEMS IN FLORICULTURE (2-12)** Greenhouse research and review of literature. Prerequisite or concurrent: Hort. 427, 428. *Mr. Mastalerz*
527. **EXPERIMENTAL PROBLEMS IN NUTRITION OF HORTICULTURAL CROPS (2-12)** Review of current research; problems for independent investigation. *Mr. Smith*
528. **PROBLEMS IN FRUIT AND VEGETABLE PROCESSING (2-12)** *Mr. McArdle*

## LANDSCAPE ARCHITECTURE (L ARCH)

425. **LANDSCAPE CONSTRUCTION PROBLEMS (3-7)** *Mr. Wilson*
434. (Re.Ed. 434). **RECREATION AREAS AND FACILITIES (3)**
- 454-455. **LANDSCAPE DESIGN (4 each)** *Mr. Polakowski*
460. **ADVANCED LANDSCAPE DESIGN (3-6)**
461. **PARK DESIGN AND ADMINISTRATION (3-6)** *Mr. Wilson*
462. **SITE PLANNING OF INSTITUTIONAL AND PUBLIC PROJECTS (3-6)**
463. **ADVANCED LANDSCAPE DESIGN (1-6)** *Mr. Wilson*
518. **ADVANCED PROBLEMS IN LANDSCAPE DESIGN (2-12)** Selected problems for original investigation in the design, construction, and maintenance of landscape architectural projects. Prerequisite: L.Arch. 455.
521. **TECHNICAL LANDSCAPE ARCHITECTURAL PRACTICES (2-12)** Specific technical and professional problems in landscape architectural planning and practice. Prerequisites: L.Arch. 460, 461.



INDUSTRIAL ARTS EDUCATION  
and  
VOCATIONAL INDUSTRIAL EDUCATION

S. LEWIS LAND, *Head of the Department of Industrial Education*  
301 Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Land and Williams; Associate Professors Pendered, Shemick, and Schaefer.

Emphasis may be placed on preparation for teaching, supervision, administration, or teacher education. Graduation from an approved curriculum in industrial arts or in vocational industrial education is required for admission to the respective fields.

INDUSTRIAL ARTS (I ART)

400. SHOP MANAGEMENT AND LAYOUT (3)

407. CURRICULUM MATERIALS AND METHODS IN INDUSTRIAL ARTS (4)

470. PROBLEMS IN SENIOR HIGH SCHOOL INDUSTRIAL ARTS (3)

574. HISTORY AND PHILOSOPHY OF INDUSTRIAL ARTS (3) Historical developments and concurrent educational philosophies of industrial arts in American education. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.

575. PROBLEMS IN INDUSTRIAL ARTS EDUCATION (3) Subject matter, projects, methods of manual and informational teaching, aids and devices, selection of text and reference materials, personnel organization, shop management, problem pupils. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.

576. SUPERVISION AND ADMINISTRATION OF INDUSTRIAL ARTS EDUCATION (3) How to organize, supervise, and administer functioning programs of industrial arts; duties of a supervisor and director of industrial arts. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.

577. TESTING IN INDUSTRIAL ARTS (3) Construction of informal manipulative and written tests; use of standardized mechanical aptitude and achievement tests; construction and use of rating scales; scoring and grading; interpretation of test results. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.

578. RESEARCH IN INDUSTRIAL ARTS (3) Research techniques in industrial arts education. Prerequisite: 6 credits in professional courses in industrial arts.

580. SEMINAR IN INDUSTRIAL ARTS (9) Directed intensive study, investigation, or research in selected phases of the program; reports and constructive criticism. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.

INDUSTRIAL EDUCATION (I ED)

402v. SUPERVISION OF VOCATIONAL EDUCATION (3)

403v. SUPERVISED FIELD WORK (6)

408v. OCCUPATIONS (3)

409v. TESTS AND MEASUREMENTS (3)

- 412v. SPECIAL PROBLEMS IN VOCATIONAL EDUCATION (4)  
 415v. PROBLEMS IN CO-ORDINATING VOCATIONAL EDUCATION (3)  
 420v. OCCUPATIONAL HYGIENE (3)  
 427v. ADVANCED COURSE OF STUDY BUILDING (3)  
 446v. IMPROVEMENT OF INSTRUCTION IN VOCATIONAL EDUCATION (4)  
 450v. SHOP LAYOUT AND MANAGEMENT (3)
- 501v. SEMINAR IN VOCATIONAL EDUCATION (12) Conferences, investigations, and discussion for advanced students and mature persons who have had experience as teachers, supervisors, or administrators.
- 506v. ADMINISTRATION OF VOCATIONAL EDUCATION (6) The job of the local director of industrial education in organizing and developing city and other local programs of industrial education. Prerequisite: 6 credits in industrial education or valid director's certificate, equivalent training and experience.
- 510v. VOCATIONAL EDUCATION FOR ADMINISTRATORS (3) Designed for school administrators and supervisors who desire an understanding of practical arts and vocational education. Prerequisite: I.Ed. 1v or trade or teaching experience.
- 550v. RESEARCH IN VOCATIONAL EDUCATION (3) Research techniques in vocational industrial education.
- 555v. CURRENT PROBLEMS IN VOCATIONAL EDUCATION (1 per unit) Recent trends and developments in part-time, full-time, and evening school education, involving critical analysis of objectives, content, and outcome.  
*Unit A. Changing Industrial, Economic, and Social Conditions (1)*  
*Unit B. Policies and Program of the American Vocational Association (1)*  
*Unit C. Federal and State Vocational Legislation, Present and Pending (1)*  
*Unit D. Financing Vocational Education (1)*  
*Unit E. Current Administrative Problems in Vocational Education (1)*  
*Unit F. Current Administrative Problems in Vocational Education (cont'd) (1)*
- 558v. FRONTIER PROBLEMS IN VOCATIONAL INDUSTRIAL EDUCATION (3 per unit)  
*Unit A. Federal Legislation (3)* Recent federal legislative activities and executive orders that bear directly and indirectly upon industrial education.  
*Unit B. Present-Day Local, Personnel, and Curriculum Problems (3)* Various plans, techniques, and practices.  
*Unit C. State and Local Supervision and Administration (3)* The more important recent problems in organization, supervision, and administration.
- 560v. PHILOSOPHY OF INDUSTRIAL EDUCATION (3) Principles and beliefs of progressive industrial education; literature for evaluating instructional practices. Prerequisite: 12 credits in industrial education or teaching experience.

## INDUSTRIAL ENGINEERING

BENJAMIN W. NIEBEL, *Head of the Department*  
 203 Engineering C

*Degrees Conferred:* M.S., M.Eng.

*Graduate Faculty:* Professors Niebel and Thuerling.

Graduate study and research are conducted in operations research, linear programming, queuing theory, and experimental design. Opportunities also exist for advanced study in automation, production engineering, product design for production, work measurement, costs and budgets, tool design, methods analysis, personnel management, and management controls.



## INDUSTRIAL ENGINEERING

For admission a student must have graduated from an accredited school with a major in industrial engineering. Graduates of other accredited engineering curriculums may be admitted after completing 27 credits in industrial engineering.

### INDUSTRIAL ENGINEERING (I E)

400. ENGINEERING FOR PRODUCTION (3) *Mr. Niebel*  
402. ENGINEERING ECONOMY (3) *Messrs. Niebel, Roscoe, and Thuering*  
404. SCIENTIFIC MANAGEMENT (2) *Messrs. Caldwell and Roscoe*  
406. FACTORY PLANNING (2) *Messrs. Thuering, Draper, and Olsen*  
422a,b,c,d,e,f. INDUSTRIAL ENGINEERING PROBLEMS (2-12) *Messrs. Niebel, Thuering, and Moss*  
423. QUALITY CONTROL (2) *Mr. Thuering*  
424. JOB EVALUATION (3) *Mr. Farwell*  
425. METHODS OF INDUSTRIAL OPERATIONS RESEARCH (3) *Mr. Guild*  
426. INDUSTRIAL AUTOMATION (3) *Mr. Bowman*  
427. ADVANCED METAL CASTING (3)  
428. FOUNDRY ENGINEERING (3)  
429. PLASTIC WORKING OF METALS (3) *Mr. Roscoe*  
430. INDUSTRIAL LEADERSHIP (3) *Mr. Caldwell*  
432. INDUSTRIAL ENGINEERING LECTURES (1-3)  
  
501. MANUFACTURING METHODS (2-8) Special projects including investigation; experimentation, design, and research of one or more special types of manufacture. *Messrs. Niebel and Thuering*  
502. MANAGEMENT METHODS (3-6) Scientific management, including management controls and mathematical programming; research on special problems. *Messrs. Thuering and Niebel*  
503. PERSONNEL RELATIONS (2-8) Research on special topics. *Mr. Williamson*  
505. GRAPHICAL COMPUTATION (2-6) Construction of natural and logarithmic scales, applications of various co-ordinate papers and construction of nomographic or alignment charts; determination of empirical formulae from engineering data. *Mr. Thuering*  
506. TIME AND MOTION STUDY (3-9) Methods of research in motion and time study; critical analysis of current literature. *Mr. Niebel*  
507. BUDGETARY CONTROL AND STANDARD COSTS (3-6) Divisional budgets as control media; establishing standard cost data, standard cost accounting procedures, and use of cost variances in controlling manufacturing operations. Prerequisite: I.E. 335.  
513. DATA PROCESSING AND PROGRAMMING (3) Theory and techniques in systems analyses applied to the programming of procedures and operations.

## INSTITUTION ADMINISTRATION

S. EARL THOMPSON, *Head of the Department*  
4A Home Economics Building

*Degrees Conferred:* M.S., M.Ed.

*Graduate Faculty:* Professors Atkinson and Thompson.

Graduate work in this field trains for management positions in institutions which provide food service and housing to large groups, such as hospitals, residence halls, chil-



## INSTITUTION ADMINISTRATION

dren's homes, and other public and private organizations. For admission, a student should have a baccalaureate degree in this or a related field.

### HOTEL ADMINISTRATION (H A)

- 440. HOTEL OPERATIONAL LIABILITIES (2)
- 445. HOTEL ORGANIZATION AND OPERATION (3)

### INSTITUTION ADMINISTRATION (IN A)

- 402. FOOD SERVICE AND HOUSING LAYOUT AND DESIGN (2)
- 410. ADVANCED QUANTITY FOOD PREPARATION (3)
- 425. FOOD AND LABOR MANAGEMENT AND CONTROL (3)
- 461. INSTITUTION ADMINISTRATION (3)
- 470. PROBLEMS IN FOOD SERVICE AND HOUSING ADMINISTRATION (3)
- 502. PROBLEMS IN INSTITUTION ADMINISTRATION (3-6) Individual study of problems in institution administration. Prerequisites: In.A. 310, 330. *Miss Atkinson*

## JOURNALISM

ROBERT M. POCKRASS, *Chairman of the Graduate Program*  
110 Carnegie Building

*Degree Conferred:* M.A.

*Graduate Faculty:* Professors Brown, Marbut, and Markham; Associate Professors Hicks and Pockrass; Assistant Professor Froke.

The student may pursue studies in the fields of news and public affairs reporting, editing, and comment in the mass media; advertising; technical problems in broadcasting and publishing; and public relations.

For admission under Plan A the student must present evidence of undergraduate credit covering the fundamentals, or equivalent professional experience in mass communications. Students who lack these prerequisites may enroll under Plan B, which may require a maximum of 18 undergraduate credits in basic communications.

### JOURNALISM (JOURN)

- |                                                                                                                                                     |                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| 401. THE PRESS, ITS CRITICS AND ETHICS (2)                                                                                                          | <i>Messrs. Brown and Dennis</i>   |
| 405. COMPARATIVE FOREIGN JOURNALISM (2)                                                                                                             | <i>Messrs. Markham and Dennis</i> |
| 421. EDITORIAL INTERPRETATION (3)                                                                                                                   | <i>Mr. Brown</i>                  |
| 424. PUBLIC AFFAIRS REPORTING (3)                                                                                                                   | <i>Mr. Goodwin</i>                |
| 430. JOURNALISM IN THE SCHOOLS (3-6)                                                                                                                | <i>Mr. Vairo</i>                  |
| 441. ADVANCED ADVERTISING COPYWRITING (3)                                                                                                           | <i>Mr. Hicks</i>                  |
| 443. ADVERTISING CAMPAIGNS (3)                                                                                                                      |                                   |
| 466. PUBLICITY AND PUBLIC RELATIONS PROBLEMS (3)                                                                                                    | <i>Mr. Vairo</i>                  |
| 468. LAW OF MASS COMMUNICATIONS (3)                                                                                                                 | <i>Messrs. Marbut and Markham</i> |
| 480. MEDIA MANAGEMENT (3)                                                                                                                           |                                   |
| 492. ADVANCED TELEVISION NEWS (3)                                                                                                                   | <i>Mr. Froke</i>                  |
| 499. INDEPENDENT STUDY IN MASS COMMUNICATIONS (2-6)                                                                                                 | <i>Mr. Goodwin</i>                |
| 505. INTERNATIONAL PRESS PROBLEMS (3-6) Legal and communications problems of the international flow of news and opinion; international press codes. | <i>Mr. Markham</i>                |

## JOURNALISM

506. SEMINAR IN COMMUNICATIONS RESEARCH METHODS (3-6) Social science measuring techniques for readership and advertising studies, media effectiveness, and propaganda results. *Mr. Markham*
508. HISTORY AND LITERATURE OF JOURNALISM (3) Readings and research in biography, history, collections of journalistic writings, and critical works. *Mr. Brown*
513. CURRENT PROBLEMS IN NEWS REPORTING AND EDITING (3) Securing, writing, display, and treatment of the news; newsroom policies and ethics. *Mr. Marbut*
521. NEWS MEDIA AND PUBLIC OPINION (3) Problems in the function, techniques, and responsibilities of press, radio, and television in forming and interpreting opinion. Prerequisite: Pl.Sc. 427, Psy. 429, or Soc. 431. *Mr. Pockrass*
540. CONTEMPORARY ADVERTISING PROBLEMS (3) Current problems and trends in the fields of advertising copy, media, planning, and research; policies and ethical standards. *Mr. Hicks*

## MATHEMATICS

JAMES B. BARTOO, *Acting Head of the Department*  
210 Sparks Building

*Degrees Conferred:* Ph.D., D.Ed., M.A., M.Ed.

*Graduate Faculty:* Professors Ayoub, Bartoo, Benton, Cohen, Curry, Orrin Frink, Johnson, Krall, and Sheffer; Associate Professors Barone, Craig, Faith, Aline Frink, Hostinsky, Kanwal, Mary McCammon, Mitchell, Raney, and Schoenfeld; Assistant Professors Husemoller, Johnson, Kist, Mack, Pervin, and Pour-El.

Graduate courses in all the principal branches of mathematics are offered each year. The department is prepared to direct research in a variety of fields, including function theory, abstract algebra, topology, number theory, statistics, numerical analysis, and all aspects of mathematical logic and foundations. A digital computer is available on the campus for students interested in numerical methods.

To be admitted without undergraduate deficiency, an applicant should have credit for at least two advanced courses beyond integral calculus.

### MATHEMATICS (MATH)

403. MODERN METHODS IN GEOMETRY (3)
404. THEORY OF NUMBERS (3)
405. FOURIER SERIES AND BOUNDARY VALUE PROBLEMS (3)
407. FOUNDATIONS OF ALGEBRA AND GEOMETRY (3)
408. APPLICATIONS OF MATHEMATICS (3)
- 409-410. PROBABILITY AND STATISTICS (3 each)
411. FINITE DIFFERENCES (3)
412. ALGEBRAIC EQUATIONS (3)
- 413-414. MATHEMATICS OF SCIENCE FOR TEACHERS (3 each)
415. SURVEY OF MODERN MATHEMATICS FOR TEACHERS (3)
416. MATHEMATICAL LOGIC FOR TEACHERS (3)
417. VECTOR AND TENSOR ANALYSIS (3)
419. ANALYTICAL MECHANICS (3)
- 420-421. INTRODUCTION TO ANALYSIS (3 each)
428. (Phil. 428). LOGICAL THEORY (3)

431. DIFFERENTIAL EQUATIONS (3)
441. MATRIX ALGEBRA (3)
- 451-452. INTRODUCTION TO APPLIED MATHEMATICS (3-6 each)
453. MATHEMATICS FOR DIGITAL COMPUTERS (3)
472. FOUNDATIONS OF GEOMETRY (3)
473. ELEMENTS OF SET THEORY AND TOPOLOGY (3)
- 480-481. INTRODUCTION TO MODERN ALGEBRA (3 each)
491. TOPICS IN APPLIED MATHEMATICS (3-9)
500. ANALYTICAL MECHANICS (3) An exposition of rigid dynamics, the potential function, and Lagrange's equations. Prerequisite: Math. 419 or Phys. 461.
- 501-502. THEORY OF FUNCTIONS OF A REAL VARIABLE (3 each) Theory of real functions, sets, measure, derivatives, and integrals. Prerequisite: Math. 420.
503. FOURIER ANALYSIS (3) Fourier series and integrals, convergence and summability, theorems on Fourier coefficients, uniqueness properties. Prerequisite or concurrent: Math. 502.
505. INTEGRAL EQUATIONS (3) Fredholm and Volterra equations, and applications. Prerequisite: Math. 421.
507. CALCULUS OF VARIATIONS (3) Prerequisites: Math. 44, 421.
- 508-509. THEORY OF FUNCTIONS OF A COMPLEX VARIABLE (3 each) Development of the complex number system; theory of analytic functions. Prerequisite: Math. 421.
510. THEORY OF GROUPS (3) Selected topics from group theory including Abelian, solvable, nilpotent, and free groups, Sylow theorems, and group extensions and representations. Prerequisite: Math. 535.
511. LINEAR ALGEBRA (3) Vector spaces and linear transformations, canonical representations, elementary divisors and invariant factors. Prerequisites: Math. 480, 441; or Math. 481.
- 513-514. ADVANCED ANALYTIC GEOMETRY (3 each) Introduction of homogeneous coordinates and their use in the study of projective properties. Prerequisite: Math. 43.
515. PARTIAL DIFFERENTIAL EQUATIONS OF MATHEMATICAL PHYSICS (3) Methods of solution of selected elliptic, parabolic, and hyperbolic partial differential equations, with reference to physical application. Prerequisite: Math. 421.
- 516-517. THEORY OF PROBABILITY (3 each) Sample spaces, combinatorial analysis, limit theorems, random walk, Markov chains, stochastic processes. Prerequisite: Math. 420.
- 520-521. PROJECTIVE GEOMETRY (3 each) General study of the subject from the postulational standpoint. Prerequisite: Math. 43. Alternate years or as required.
- 522-523. METRIC DIFFERENTIAL GEOMETRY (3 each) The usual classical treatment of the subject. Prerequisite: Math. 43.
- 530-531. TOPOLOGY (3 each) Topological spaces, combinatorial topology, applications to algebra and analysis.
532. THEORY OF SETS (3) Formal development of set theory on a logical basis and related methodological problems; applications to the foundations of mathematics. Prerequisite: Math. (Phil.) 428.



## MATHEMATICS

534. THEORY OF ALGEBRAIC NUMBERS (3) Introduction to the number theory of quadratic fields, with study of the theory of ideals in quadratic and higher fields, with application. Prerequisites: Math. 404, 480.
535. MODERN ALGEBRA (3) First graduate course in abstract algebra including the basic theory of semigroups, rings, fields, operator groups, and factorization. Prerequisites: Math. 480, 441; or Math. 481.
537. THEORY OF FIELDS (3) Selected topics from field theory including extensions and structure of fields; Galois theory; algebraically closed, ordered, and algebraic number fields. Prerequisite: Math. 535.
538. THEORY OF RINGS (3) Selected topics from commutative and noncommutative ring theory including ideals, the Jacobson structure theory, and special classes of rings. Prerequisite: Math. 535.
539. LATTICE THEORY (3) Selected topics from lattice theory including complete, modular, complemented, and distributive lattices and applications. Prerequisite: Math. 535.
- 542-543. THEORY OF STATISTICS (3 each) Univariate and multi-variate distributions, sampling distributions, theory of estimation, statistical hypotheses. Prerequisites: Math. 409, 421.
- 550-551. (Phil. 550-551). FOUNDATIONS OF MATHEMATICAL LOGIC (3 each) The nature of logical basis of mathematics; critical examination and development of the basic parts of logical calculus. Prerequisite: Math. 480 or Math. (Phil.) 428.
- 552-553. NUMERICAL METHODS (3 each) Procedures for practical calculation, including interpolation, solution of equations, iterative methods, harmonic analysis, and use of modern calculating equipment. Prerequisite: Math. 420.
554. (Phil. 554). METAMATHEMATICS (3) Prooftheoretic and modeltheoretic study of systems: Gödel's theorem, relative and absolute consistency proofs, decidability, properties of relational structures, mathematical applications. Prerequisite: Math. (Phil.) 428.
555. SELECTED TOPICS IN MATHEMATICS FOR CHEMISTS (3) An introduction to matrices, groups, group representations, characters, and orthogonal functions.
556. (Phil. 556). RECURSION THEORY (3) Recursive functions; recursive and recursively enumerable sets; equivalent formulations of computability; Church's thesis; related topics from current literature. Prerequisite: Math. (Phil.) 428.
- 560-561. THEORY OF DIFFERENTIAL EQUATIONS (3 each) Prerequisites: Math. 44, 421.
565. FUNCTIONAL ANALYSIS (3) Theory of Banach and Hilbert spaces, including functionals and operators, and related topics. Prerequisite: Math. 420.
570. SPECIAL TOPICS IN GEOMETRY (3-6)
571. SPECIAL TOPICS IN ANALYSIS (3-6)
572. SPECIAL TOPICS IN ALGEBRA (3-6)
573. SPECIAL TOPICS IN APPLIED MATHEMATICS (3-6)
574. SPECIAL TOPICS IN FOUNDATIONS OF MATHEMATICS (3-6)
- 575-576. MATHEMATICS SEMINAR (1-6 each) Selected topics from recent mathematical developments.

# MECHANICAL ENGINEERING

MAURICE S. GJESDAHL, *Acting Head of the Department*  
207 Mechanical Engineering Building

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Professors Ambrosius, DiIlio, Dusinberre, Gjesdahl, Hussmann, and Meyer; Associate Professors Brickman, Lester, and White.

Graduate programs in mechanical engineering emphasize heat power or machine design. Courses and facilities permit studies in heat transfer, advanced machine design, internal combustion engines, machine dynamics, gas turbines and gas dynamics, lubrication, automatic control systems, and power generation and utilization.

To be admitted, a student should be a graduate of an accredited curriculum in mechanical engineering or the equivalent. Graduates of other accredited engineering or physical science curriculums may be admitted, but will be required to make up undergraduate deficiencies without graduate credit.

## MECHANICAL ENGINEERING (M E)

- 401a,b,c,d. MECHANICAL ENGINEERING (3-12)
- 402. AIR CONDITIONING (3)
- 403. ROCKET PROPULSION (3)
- 409. GAS TURBINES (3)
- 410. POWER PLANTS (3)
- 411. REFRIGERATION (3)
- 412. FUNDAMENTALS OF HEAT TRANSFER (3)
- 413. INTERNAL COMBUSTION ENGINES (3)
- 417. THEORY OF ENGINEERING INSTRUMENTS (3)
- 418. PRINCIPLES OF TURBOMACHINERY (3)
- 450. DESIGN OF MACHINE TOOLS (3)
- 451. ADVANCED MACHINE DESIGN PROBLEMS (3)
- 452. MACHINE DESIGN ANALYSIS (3)
- 453. BEARING DESIGN AND LUBRICATION (3)
- 455. AUTOMATIC CONTROL SYSTEMS (3)
- 457. ADVANCED MECHANISMS (3)
  
- 502. ADVANCED GAS TURBINES (3-6) Analytical study of gas turbine compressors and turbines; combustion; complex cycles; recent developments. Prerequisite: M.E. 409.
- 504. ADVANCED ENGINEERING THERMODYNAMICS (3-6) Pure and applied thermodynamics including its application to advanced engineering problems; collateral reading and discussion of the classical works on the subject. Prerequisite: M.E. 32.
- 505. HEAT TRANSMISSION (3-6) Applications of principles of heat transfer to efficient design of mechanical engineering equipment. Prerequisite: M.E. 412.
- 506. SELECTED TOPICS IN MECHANICAL ENGINEERING (1-12) Advanced courses adapted to the individual requirements of graduates in mechanical engineering.
- 510. MIXTURE PREPARATION AND COMBUSTION IN INTERNAL COMBUSTION ENGINES (3-6) Performance and design of carburetors and injection systems; combustion and its control in spark-ignition and compression-ignition engines. Prerequisite: M.E. 413.

## MECHANICAL ENGINEERING

550. ANALYSIS OF DESIGN PROBLEMS (3) Case problems in machine design requiring integrated application of engineering knowledge.
552. ADVANCED DYNAMICS OF MACHINES (3-6) Linear and torsional vibrations in and balancing of rotating and reciprocating machinery; exact analysis of stresses produced by these and other dynamic forces in machine parts. Prerequisites: E.Mch. 12, M.E. 54.
553. FRICTION AND LUBRICATION (3) The hydrodynamic theory of lubrication and methods of applying it to bearing design, together with a survey of methods of testing lubricants.
555. AUTOMATIC CONTROL SYSTEMS (3) Advanced problems and techniques in the design of automatic control systems with emphasis on stability, controller design, and optimum performance. Prerequisite: M.E. 455.
557. MECHANISM SYNTHESIS (3) Design and analysis of mechanisms for specific motion and energy requirements; intermittent mechanisms. Prerequisite: M.E. 457.
580. INVESTIGATION PROJECTS (2-6) Special experimental studies or investigations in mechanical engineering, adapted to individual requirements.

## METALLURGY

ROBERT W. LINDSAY, *Head of the Department*  
5 Mineral Sciences Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Davis, Lindsay, and Read; Associate Professor Muan; Assistant Professor Ryba.

There is opportunity for a student to specialize, both in research and in course work, in chemical metallurgy, physical metallurgy, mechanical metallurgy, or the science of metals. Minor work in any of these specializations is available for students majoring in another field.

The requirements for admission are a satisfactory bachelor's degree in metallurgy, metallurgical engineering, chemistry, chemical engineering, physics, mechanical engineering, or engineering mechanics; or a satisfactory bachelor's degree in another field, provided it has included the equivalents of mathematics through integral calculus; 8 credits of physics; 12 of chemistry; 10 of other scientific, engineering, or mineral science fields; and 10 of metallurgy. Students who lack some of these requirements may be admitted but are required to take the prerequisite courses without being able to apply them toward an advanced degree.

### METALLURGY (METAL)

405. FERROUS METALLOGRAPHY (3)  
406. NONFERROUS METALLOGRAPHY (3)  
407. METALLURGICAL ENGINEERING I (3)  
408. METALLURGICAL ENGINEERING II (3)  
409. METALLURGICAL INVESTIGATIONS I (3)  
410. METALLURGICAL INVESTIGATIONS II (3)  
411. ADVANCED PHYSICAL METALLURGY (3)  
412. EXPERIMENTAL METALLURGY (3)  
413. ADVANCED CHEMICAL METALLURGY (3)



501. METALLURGICAL PROBLEMS (1-6 per semester) Independent study of special problems in metallurgy. Prerequisites: Metal. 411, 413.
502. SEMINAR IN METALLURGY (1-6) Conferences, reading, reports, and special lectures.
505. NUCLEAR REACTOR MATERIALS (3) Extractive metallurgy, alloy theory, transformations, physical properties, mechanical behavior, and corrosion of principal reactor materials; radiation damage; fuel element manufacture. Prerequisites: Metal. 59, E.Mch. 13.
515. CORROSION OF METALS (3) Phenomena and theories of metallic corrosion; principles of alloy selection for engineering and structural uses in corrosive environments. Prerequisites: Metal. 411, 413. Mr. Read
516. FLOW AND FRACTURE OF SOLIDS (3) Phenomenological and theoretical treatment of flow and fracture in solids.
518. CONSTITUTION OF METALLURGICAL SYSTEMS (3) Application of thermodynamic principles to study of heterogeneous equilibrium in alloy, slag, and slag-metal systems. Prerequisites: Metal. 411, 413. Mr. Davis
519. ADVANCED FERROUS METALLURGY (3) Physicochemical principles applied to reactions in iron- and steelmaking systems, including gas, metal, slag, and refractory phases. Prerequisite: Chem. 461. Mr. Muan
520. FOUNDRY METALLURGY (3) Principles of foundry metallurgy; application to foundry operations for various ferrous and nonferrous casting alloys. Prerequisites: Metal. 411, 413. Mr. Lindsay
522. SOLID-PHASE REACTIONS IN METALS (3) Mechanism and rate determining factors in solid-phase reactions in metals; diffusion processes, nucleation theory, precipitations from solid solution, eutectoid decomposition and order-disorder phenomena. Prerequisites: Metal. 411, 413. Mr. Lindsay
524. ADVANCED METAL WORKING (3) Elements of mathematical theory of plasticity; metal working processes; measurement of deformations in metal working; theory of metal working. Prerequisite: Metal. 516.
525. METAL FINISHING (3) Metallic coatings and their metallurgical properties; theories and problems of application, utilization, and evaluation. Prerequisites: Metal. 411, 413. Mr. Read

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in metallurgical studies are listed under Mineral Sciences in Part II of this bulletin.

## METEOROLOGY

HANS NEUBERGER, *Head of the Department*  
322 Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Hosler, Neuberger, and Panofsky; Associate Professors Blackadar and Stephens.

Candidates in meteorology may specialize in aerosol and cloud physics, various phases of dynamic meteorology including turbulence and atmospheric circulation.

## METEOROLOGY

atmospheric optics, macro- and microclimatology, agricultural meteorology, synoptic meteorology, or meteorological instrumentation.

Requirements for admission include mathematics through differential equations, one year of college physics, and 12 credits in meteorology. Students with a strong background in mathematics, physics, or engineering may be admitted with deficiencies but must make up such deficiencies before they are admitted to candidacy for a degree.

### METEOROLOGY (METEO)

- 400. METEOROLOGY FOR TEACHERS (3)
  - 411. INTRODUCTION TO SYNOPTIC METEOROLOGY (3)
  - 412. SYNOPTIC METEOROLOGY (3)
  - 418. INTRODUCTORY PHYSICS OF THE UPPER ATMOSPHERE (3)
  - 420. TROPICAL METEOROLOGY (3)
  - 430. INTRODUCTION TO SYNOPTIC METEOROLOGY LABORATORY (3)
  - 431. SYNOPTIC METEOROLOGY LABORATORY I (3)
  - 432. SYNOPTIC METEOROLOGY LABORATORY II (2-10)
  - 433. ADVANCED SYNOPTIC ANALYTICAL TECHNIQUES (3)
  - 443. PHYSICAL METEOROLOGY (3)
  - 445. HYDROMETEOROLOGY (3)
  - 450. APPLICATIONS OF STATISTICS TO METEOROLOGY (3)
  - 451. THERMODYNAMICS OF THE ATMOSPHERE (3)
  - 452. HYDRODYNAMICS OF THE ATMOSPHERE (3)
  - 461. THEORY OF METEOROLOGICAL INSTRUMENTS (3)
  - 472. PHYSICAL AND DYNAMIC CLIMATOLOGY (3)
  - 492. METEOROLOGICAL SEMINAR (2)
  
  - 500. METEOROLOGICAL SEMINAR (1-3) Discussion of meteorological reports and papers; scientific outlook. Prerequisites: Meteo. 412, 451.
  - 502. SELECTED TOPICS OF ADVANCED METEOROLOGY (2) Current problems in meteorology. Prerequisite: a minimum of 15 credits in meteorology.
  - 503. ATMOSPHERIC TURBULENCE (3) Atmospheric diffusion, heat conduction, friction, and evaporation; statistical properties of turbulence.
  - 504. ADVANCED DYNAMIC METEOROLOGY (3) Introduction to perturbation theory with application to gravitational and long waves; principles of dynamic-numerical forecast methods. Prerequisite: Meteo. 452.
  - 505. BIOCLIMATOLOGY (2) Climatic phenomena in their relation to life. Prerequisite: Meteo. 472.
  - 506. ADVANCED METEOROLOGICAL ANALYSIS (2-6) Physical analysis of atmospheric phenomena; synoptic analysis of weather phenomena for advanced students. Prerequisite: Meteo. 412.
  - 507. DYNAMIC OCEANOGRAPHY (2) Physical properties of sea water; heat balance of the oceans; theory and observations of ocean currents, waves, and tides.
  - 508. PHYSICS OF THE UPPER ATMOSPHERE (2) Temperature distribution, composition, and electrical characteristics of the upper atmosphere; theories of aurora and light of the night sky.
  - 509. THEORETICAL CLIMATOLOGY (2) Theory of latitudinal, annual, and diurnal temperature changes; theories of climatic changes; microclimate.
  - 510. CLOUD PHYSICS (2) Current theories on phase changes in clouds and mechanisms responsible for precipitation; techniques of cloud modification and control.
- NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in meteorological studies are listed under Mineral Sciences in Part II of this bulletin.*

## MINERAL ECONOMICS

JOHN D. RIDGE, *Head of the Department*  
207 Mineral Sciences Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professor Ridge; Associate Professor Schanz.

A student may specialize in the economics of exploration for, and the extraction, beneficiation, and utilization of, the ferrous and nonferrous metals, the nonmetallics, the fuels, and ground water. Work is also offered in property evaluation, analysis of mineral data, and the influence of technological advances on mineral economics.

The requirements for admission are 24 credits in chemistry, physics, and mathematics; 12 in geology, mineralogy, and/or the biological sciences; 9 in mineral economics, economics, commerce, and/or geography; and 6 in mining, metallurgy, petroleum engineering, ceramics, and/or industrial engineering.

Students having a deficiency of 9 credits or fewer in this total of 51 may be admitted as regular graduate students but will be required to make up such deficiencies without the credits being applicable toward the advanced degree.

## MINERAL ECONOMICS (MN EC)

- 400. SEMINAR (1)
- 453. NONMETALLIC MINERALS (3)
- 463. MINERAL ECONOMY OF THE U.S.S.R. (3)
- 483. THE METALS AND THEIR ORES (3)
- 484. THE SOLID FUELS (3)
- 486. PETROLEUM AND NATURAL GAS ECONOMICS (3)
- 490. MINERAL VALUATION (3)
- 491. ANALYSIS OF MINERAL DATA (2)
- 500. ADVANCED PRINCIPLES OF MINERAL ECONOMICS (3-6) Economic history of mineral industries, research methods, economics of mineral exploitation and utilization, mineral policy.
- 501. RESEARCH IN MINERAL ECONOMICS (3-6) Investigation in specialized fields of research in mineral economics. Prerequisite: 3 credits in Mn.Ec. 500.
- 502. TECHNOLOGIC INFLUENCES (3-9) Relationship of technologic advancements to economic development of the mineral industries. Prerequisite: 3 credits in Mn.Ec. 500.
- 505. PROBLEMS OF MINERAL ECONOMICS (3-12) Determination of basic technologic-economic patterns of selected mineral industries. Prerequisite: 3 credits in Mn.Ec. 500.

## MINERAL PREPARATION

H. BEECHER CHARMBURY, *Head of the Department*  
4 Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Charmbury and Sun; Assistant Professor Lovell.

Areas in which students may specialize include the fundamentals of gravity, electrical, and chemical methods of beneficiating natural mineral deposits. Graduate



## MINERAL PREPARATION

work may also be undertaken on the properties of specific minerals as they are related to beneficiation.

Graduates with a bachelor's degree in such scientific fields as chemistry, physics, and mathematics, and in such engineering fields as mining, metallurgy, ceramics, fuel technology, and mechanical, electrical, and civil engineering are eligible for admission. However, graduates in the above fields are required to take 6 credits of undergraduate courses in mineral preparation along with their graduate program.

### MINERAL PREPARATION (MN PR)

400. MINERAL PREPARATION SEMINAR (1)  
403. FLOWSHEETS OF MINERAL PREPARATION PLANTS (3)  
404. PLANT LAYOUT AND DESIGN (3)  
410. COAL PREPARATION (3)  
415. MINERAL PREPARATION TESTING (2)  
416. UNIT OPERATIONS (3)  
457. FIELD TRIP (1)
502. FROTH FLOTATION AND AGGLOMERATION (3) Intensive study of theory and applications of froth flotation and agglomeration. Prerequisite: Mn.Pr. 416.  
Mr. Sun
504. MINERAL PREPARATION RESEARCH (1-6 per semester) Research work on specific problems in mineral preparation. Prerequisite: Mn.Pr. 416 or 410.  
Mr. Charmbury and Staff
505. GRAVITY PROCESSES AND MISCELLANEOUS METHODS OF MINERAL PREPARATION (3) Intensive study of theory and applications of gravity, magnetic, electrostatic, centrifugal, and dense-media processes of mineral concentration. Prerequisite: Mn.Pr. 416.  
Mr. Mitchell
506. MINERAL PREPARATION PLANT DESIGN (3-10) Layout, design, and selection of equipment for specific mineral preparation plant projects. Prerequisite: Mn.Pr. 416.  
Mr. Mitchell
507. CHEMICAL PROCESSES OF MINERAL PREPARATION (3) Practice and theory of methods to upgrade ores by chemical treatment including roasting, solubility separations, surface phenomena, and reactions. Prerequisite: Mn.Pr. 416. Mr. Lovell
- NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in mineral preparation studies are listed under Mineral Sciences in Part II of this bulletin.

## MINERALOGY AND PETROLOGY

JOHN C. GRIFFITHS, *Head of the Department of Mineralogy*  
114 Mineral Sciences Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Bates, Griffiths, and Krynine; Associate Professor Wright.

Areas of specialization include igneous, sedimentary, and metamorphic petrology, mineralogy, crystal chemistry, X-ray mineralogy, clay mineralogy, ore mineralogy, and applications of statistics in the earth sciences.

The general requirements for admission are mathematics through integral calculus, chemistry through quantitative analysis, 10 credits of general physics, 30 credits of geology, petrology, and mineralogy including microscopical petrography (i.e., an equivalent to Min. 483, acceptable to the faculty).

Additional specific requirements must be fulfilled in most areas of specialization. Deficiencies may, in most cases, be made up after admission.

## MINERALOGY (MIN)

460. OPTICAL MINERALOGY (3) *Mr. Wright*  
 483. Petrology I (3) *Mr. Griffiths*  
 484. PETROLOGY II (3) *Mr. Griffiths*
500. OPTICAL CRYSTALLOGRAPHY OF MINERALS (3) Optical methods, microscopic techniques, and measurement of optical constants of crystals; theory and application of the universal stage. Prerequisite: Min. 460. *Mr. Wright*
- 501a. PETROLOGY (3-6) Microscopic study of rocks, emphasizing classification and genetic relationships. *Messrs. Krynine, Tuttle, and Griffiths*
502. MINERALOGICAL PROBLEMS (3) Original study of some limited mineralogical or petrological problems.
504. THEORETICAL MINERALOGY (3) Crystal chemistry and crystal physics applied to solid solution, polymorphism, crystal growth, and related phenomena. *Mr. Bates*
505. MINERALOGY SEMINAR (1-2) Reading, presentation, and discussion of literature dealing with various phases of theoretical mineralogy. Topics are selected to meet the interests of the majority of the students. *Messrs. Krynine, Tuttle, Bates, Griffiths, and Brindley*
- \*510. METAMORPHIC PETROLOGY (2-6) Detailed review of chemical, mineralogical, and structural changes that take place during metamorphism. Prerequisite: Min. 483.
511. SEDIMENTARY PETROLOGY (3-4) Composition, texture, structure, mass properties of sediments; dynamic processes in complex natural systems; sedimentary stages: weathering, erosion, transport, deposition, and lithification. Prerequisite: Min. 483. Concurrent: Min. 513. *Mr. Krynine*
512. SEDIMENTARY PETROLOGY, CONTINUED (2-4) Diastrophism and tectonic background of sedimentation; depositional loci; classification of sediments: quartzites, graywackes, arkoses; chemical sediments; paleogeography, paleoclimatology, oil finding. Prerequisite: Min. 511. Concurrent: Min. 514. *Mr. Krynine*
513. METHODS OF ANALYSIS OF SEDIMENTS (3) Principles and practices used in analyzing sedimentary rocks for size, shape, and accessory (heavy) minerals. Concurrent: Min. 511. *Mr. Griffiths*
514. APPLIED SEDIMENTOLOGY (3) Design and control in analysis of sedimentary rocks; application of these techniques to industrial problems. Concurrent: Min. 512. *Mr. Griffiths*
- †517. SEDIMENTS OF THE WORLD (1-9) Microscopic and field studies of representative American and foreign rock suites; correlation with paleogeographic, geotectonic, economic data. Prerequisites: Min. 512, 514. *Mr. Krynine*
520. STUDY OF ACCESSORY MINERALS (2-4) Detailed study of accessory (heavy) minerals; their significance in problems of provenance, petrogenesis, mineral str-

\*Credits to be arranged, 2-4 per semester.

†Credits to be arranged, 1-3 per semester.



## MINERALOGY

tigraphy, and paleogeography. Prerequisites: Min. 511, 512, 513, 514.

Mr. Griffiths

521. COLOR IN MINERALS (1-2) Nature of light absorption as a function of chemical composition for solutions, glasses, and minerals. Mr. Weyl

524. INTRODUCTION TO SEDIMENTATION (3) Concurrent: Min. 483. Mr. Krynine

525. IGNEOUS PETROLOGY (2-6) Origin, distribution, and composition of igneous rocks. Prerequisites: Min. 483, 500, 527; G.G. 513. Mr. Tuttle

526. STATISTICAL PROBLEMS IN SEDIMENTARY GEOLOGY (3) Application of experimental design, sampling procedures, multiple regression and discriminant analysis in solving problems in sedimentary petrography. Prerequisites: Min. 514; Math. 410 or Agro. 545. Mr. Griffiths

527. IGNEOUS AND METAMORPHIC MINERALOGY (3) Structural and compositional variations of minerals in igneous and metamorphic rocks.

528. MINERALOGICAL CRYSTALLOGRAPHY (2-3) Application of X-ray and morphological crystallography to mineralogy and petrology.

529. RADIOACTIVITY IN ROCKS (1-2)

Mr. Wright

530. (Cer.T. 530). STRUCTURE, PROPERTIES, AND OCCURRENCE OF CLAY MINERALS (2-5) Structure analysis and identification of clay minerals; mineral transformations and behavior; occurrence, genesis, and petrography of fine-grained sediments. Messrs. Griffiths, Bates, and Brindley

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in mineralogical studies are listed under Mineral Sciences in Part II of this bulletin.

## MINING ENGINEERING

HOWARD L. HARTMAN, *Head of the Department of Mining*  
305B Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Hartman and Mitchell; Associate Professor Kochanowsky.

Areas of specialization which may be followed in research and course work include mine property valuation and economics of mining engineering (ore estimation, cost analysis and control, budgeting), mechanization and mine plant (unit operations, materials handling, continuous mining, power supply), development and exploitation methods (mine planning and layout, design of systems), production engineering and operational analysis (time study, standards, job rating, operations research), environmental control (gas and dust technology, ventilation, air conditioning, hygiene, illumination, safety), and rock mechanics (stress analysis, roof and ground control, penetration, fragmentation).

A bachelor's degree in mining engineering or some related engineering field is required for admission to graduate work. Students may be required to make up deficiencies in their area of specialization. Certain basic, related courses outside the department may be approved as part of the major.

### MINING (MNG)

401. MINE PLANT ENGINEERING I (3)

402. MINE PLANT ENGINEERING II (3)

410. MINING ENGINEERING ANALYSIS (2)



## MINING ENGINEERING

- 411. MINE PRODUCTION ENGINEERING (2)
- 412. MINE MANAGEMENT (2)
- 422. MINE VENTILATION AND AIR CONDITIONING (3)
- 424. MINE SAFETY ENGINEERING (1)
- 431. ROCK MECHANICS (2)
- 451-452. ADVANCED MINING ENGINEERING I and II (1 each)
- 490. SENIOR MINING SEMINAR (1)
  
- 513. MINE COST ANALYSIS (3) Nature of mining costs, their analysis and control: depreciation and depletion, capital and operating costs, budgets, records.
- 514. MINE OPERATIONS ANALYSIS (3) Scientific planning and layout of mining operations based on time studies, mathematical analysis, and proportionality of centroids of reserves. Prerequisites: Math. 44 or 45, Mng. 411.
- 525. DUST TECHNOLOGY (3) Physical and chemical properties of dusts; airborne dust determinations and analysis; dust control applicable to mills and mines. Prerequisite: Mng. 422.
- 526. MINE VENTILATION (3) Airflow in mine openings and its control; network solution by mathematics and computer; design of mine and industrial ventilation systems. Prerequisite: Mng. 422.
- 528. MINE AIR CONDITIONING (3) Thermodynamics of vapor mixtures; heat flow through rock; physiological effects of hot, humid environments; design of temperature-humidity control systems. Prerequisite: Mng. 422.
- 532. ROCK MECHANICS (3) Behavior of rock under static loading; underground stress instrumentation; experimental stress analysis; design of mine openings; theories of subsidence. Prerequisite: Mng. 431.
- 541. THEORY OF ROCK PENETRATION (3) Behavior of rock under dynamic loads intended to penetrate; basic energy relations; application of theory to drilling and other penetration. Prerequisites: E.Mch. 13, Mng. 30, Phys. 285.
- 542. THEORY OF ROCK FRAGMENTATION (3) Behavior of rock under dynamic loads intended to fragment; physical chemistry of explosives; detonation; theory of blasting; design of drill rounds. Prerequisites: E.Mch. 13, Mng. 30, Phys. 285.
- 580. MINING ENGINEERING RESEARCH (1-3 per semester) Supervised research on a specific problem involved in mining science or technology.
- 590. GRADUATE MINING SEMINAR (1 per semester) Preparation and presentation of formal papers on problems of an advanced nature in mining engineering. Required each semester in residence.

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in mining studies are listed under Mineral Sciences in Part II of this bulletin.*

## MUSIC

HUMMEL FISHBURN, *Head of the Department*  
217 Carnegie Building

*Degree Conferred:* M.A.

*Graduate Faculty:* Professors Fishburn, Henninger, and Taylor; Associate Professors Ceiga and Karhan; Assistant Professor Brinsmaid.

In his graduate program a student may emphasize one of the following areas, or may elect a program including work in all of them: theory, performance, music literature,

## MUSIC

and creative music. The minor must be chosen from the liberal arts. Admission to this graduate program requires completion of a recognized music curriculum.

### MUSIC (MUSIC)

- 407. PIANO LITERATURE (3)
- 408. VOCAL LITERATURE (3)
- 410. MUSIC OF THE 20TH CENTURY (3)
- 411. LITERATURE OF THE VIOLIN (3)
- 412. MUSIC OF THE BAROQUE PERIOD (3)
- \*429. SINGER'S STYLE AND INTERPRETATION (3) Fee \$50.
- 456. ELEMENTARY COUNTERPOINT (3)
- 459. MODERN INSTRUMENTAL ARRANGING (3)
- 466. ADVANCED CONDUCTING (3)
  
- \*503. ADVANCED STRINGED INSTRUMENTS (3) Study, repertoire building, and recital performance. Fee \$50.
- \*511. ADVANCED PIANO (3) Piano literature of all periods for public performance. Fee \$50.
- \*531. ADVANCED ORGAN (3) Study, repertoire building, and recital performance. Prerequisite: 4 credits of Music 31 and/or 38. Fee \$60.
- 543. MODERN HARMONY (3) Harmonic writing based on 20th century practices with attention to traditional idioms that serve as foundation.
- 557. SYMPHONIC STRUCTURE (3) Survey of the evolution and application of the forms used in symphony, sonata, concerto, string quartet, and related works. Prerequisite: Music 57.
- \*558. FREE COMPOSITION (3) Composition: vocal and instrumental, standard or modern idioms. Prerequisite: 18 credits in harmony, counterpoint, and piano.
- 563. FREE ARRANGING (3) Correct procedure in arranging for vocal and instrumental ensembles; practical exercises in quartets, glee clubs, and choruses; small instrumental groups, band, and orchestra. Prerequisite: 18 credits in harmony, including 3 of orchestration.
- 567. THE LITERATURE OF THE ORCHESTRA (3) The suite, symphony, tone poem, and overture from the point of view of appreciation, form, and orchestration. Prerequisites: Music 6 and theoretical knowledge of the key instruments of the orchestra.

## MUSIC EDUCATION

HUMMEL FISHBURN, *Head of the Department*  
217 Carnegie Building

*Degrees Conferred:* D.Ed., M.Ed.

*Graduate Faculty:* Professors Andrews, Dunlop, and Fishburn; Associate Professors Campbell and Karhan.

A student majoring in music education is required to offer a minor in music. However, the master's program must include some work, and the doctoral program considerable work, in the area of general education.

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\*May be repeated for a total of 12 credits.

Doctoral students may specialize in vocal, instrumental, or theoretical music in elementary, secondary, or college teaching; but the degree requires work in each of these fields.

For admission to a graduate program a student must have completed a recognized music education curriculum.

## MUSIC EDUCATION (MU ED)

- 446. THE ELEMENTARY MUSIC SPECIALIST (3)
- 462. PEDAGOGY OF THEORY (3)
- 468. THE TEACHING OF PIANO (3)
- 469. BAND AND ORCHESTRA TECHNIQUE (3)
- 470. CHORAL TECHNIQUE (3)
- 475. OBJECTIVES AND PROBLEMS IN ELEMENTARY MUSIC EDUCATION (3)
- 480. CHORAL PROGRAM IN THE SECONDARY SCHOOL (3)
  
- 500. MUSIC EDUCATION SEMINAR (3-6) Problems of various phases of music education, both instrumental and vocal; research and literature dealing with these problems.
  
- 569. PRESENT-DAY TRENDS IN INSTRUMENTAL MUSIC (3) New methods and materials for band, orchestra, and ensembles.
  
- 572. INSTRUMENTAL PEDAGOGY (3-6) Research problems in band and orchestra. Prerequisite: Mu.Ed. 54 or practical experience.
  
- 573. THE MATERIALS OF APPRECIATION (3) Methods and materials for development of music appreciation in elementary and secondary schools. Prerequisites: Music 5, teaching experience.
  
- 574. PRESENT-DAY TRENDS IN MUSIC EDUCATION (3-6) Present-day music education materials and methods (elementary and secondary levels) in relation to modern educational philosophy; emphasis upon practical problems presented by members of the class. Prerequisites: Mu.Ed. 48, teaching experience.
  
- 575. THE JUNIOR HIGH SCHOOL MUSIC CURRICULUM (3) Instructional materials, procedures, curricular and extracurricular activities, integration with other subjects.
  
- 576. MUSIC SUPERVISION (3) Current educational procedures in training music supervisors.
  
- 580. FIELD PROJECTS IN JUNIOR AND SENIOR HIGH SCHOOL MUSIC (3) Curricular problems to be carried on under actual school conditions; individual work under supervision. Prerequisites: teaching experience, 30 credits of graduate study.
  
- 594. PEDAGOGY OF EAR TRAINING (3) Materials and methods for training the listener to grasp, understand, and write what is heard from melody to four-part harmony. Prerequisite: 12 credits in ear training and/or harmony.

## NUCLEAR ENGINEERING

NUNZIO J. PALLADINO, *Head of the Department*  
402 Sackett Building

*Degrees Conferred:* M.S., M.Eng.

A student may specialize in reactor analysis, reactor heat transfer, reactor structures, nuclear materials, or reactor instrumentation and control. Admission requires a bach-



## NUCLEAR ENGINEERING

elor's degree in engineering or in the physical sciences. Students who have not had appropriate undergraduate courses in nuclear physics and partial differential equations will be required to schedule them.

### NUCLEAR ENGINEERING (NUC E)

410. NUCLEAR ENGINEERING (3)

411. NUCLEAR ENGINEERING (3)

501. REACTOR ENGINEERING (3) Reactor controls, shielding of nuclear reactors, stress analysis of reactor materials, power cycle analysis, breeding, and advanced design considerations. Prerequisite or concurrent: Phys. 566.

502. REACTOR ENGINEERING LABORATORY (1-5) Reactor experiments devised to acquaint the student with reactor technology. Prerequisite or concurrent: Phys. 566.

503. THERMONUCLEAR ENGINEERING (3) Binary fusion reactions; microscopic and macroscopic phenomena in a completely ionized gas; electromagnetic confinement; design, operation, and diagnostics of experiments. Prerequisite: Math. 452.

550. SPECIAL TOPICS IN NUCLEAR ENGINEERING (1-12) Theoretical studies in nuclear engineering with or without associated experimental work. Prerequisites: Math. 44, Phys. 406.

### PHYSICAL SCIENCE (PH SC)

501. SEMINAR IN NUCLEAR SCIENCE AND ENGINEERING (0)

## PETROLEUM AND NATURAL GAS ENGINEERING

C. DREW STAHL

*Head of the Department of Petroleum and Natural Gas*

26 Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Nielsen and Slobod; Associate Professors Burcik and Stahl; Assistant Professor Bissey.

Areas of specialization include experimental and theoretical studies of water flooding and the newer methods for displacing oil from porous media, methods for calculating reservoir performance, scaled laboratory studies of reservoir phenomena, and drilling and well completion problems.

Students who expect to enter graduate study in this field with a degree in another curriculum should present 20 credits of chemistry and physics, 6 of geology, 15 of engineering science, and credit for mathematics through integral calculus. A limited number of deficiencies may be made up after admission.

Certain closely related courses outside the department may be counted as petroleum and natural gas credits toward the degree.

### PETROLEUM AND NATURAL GAS (P N G)

410. APPLIED RESERVOIR ENGINEERING (3)

421. RESERVOIR ENGINEERING (3)

- 431. DRILLING FLUIDS (2)
- 450. DRILLING DESIGN AND PRODUCTION ENGINEERING (4)
- 480. PRODUCTION PROCESS ENGINEERING (3)
- 481. NATURAL GAS AND GASOLINE PLANTS (2)
- 485. ENGINEERING IN SECONDARY RECOVERY (3)
- 490. ADVANCED CORE TESTING (3)
  
- 510. FLOW OF HOMOGENEOUS FLUIDS THROUGH POROUS MEDIA (3) Concepts and mathematics describing steady and unsteady state flow in porous media for various initial and boundary conditions.
- \*512. RESERVIOR ENGINEERING (3-6) Applications of the principles of fluid behavior in porous media to the analysis of complex reservoir behavior; log interpretation. Prerequisite: P.N.G. 510.
- 515. SECONDARY RECOVERY (3) Methods of predicting oil recovery by immiscible fluid injection.
- 517. CASE STUDIES OF SECONDARY RECOVERY (1-3) Interpretation and critical analysis of production and injection characteristics of typical water flood operations. Prerequisite: P.N.G. 515 or 485.
- 520. PHASE RELATIONS IN RESERVOIR ENGINEERING (3) Phase relations as applied to condensate and retrograde condensate reservoirs and to other problems in petroleum production.
- 525. SPECIAL TOPICS IN PETROLEUM ENGINEERING (2-6)
- 530. NATURAL GAS ENGINEERING (1-3) Flow in producing or storage reservoirs; gas well testing; transmission systems; storage cycles; current developments. Prerequisite: P.N.G. 481.
- †535. SEMINAR (1-3)

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in petroleum and natural gas studies are listed under Mineral Sciences in Part II of this bulletin.*

## PHILOSOPHY

JOHN M. ANDERSON, *Head of the Department*  
119 Sparks Building

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Professors Anderson, Finch, Freund, and Mourant; Associate Professors Johnstone and Pape.

A student may concentrate on history of philosophy, logic and scientific methods, or value theory. Undergraduate preparation should include a major in philosophy, but a strong minor may also be acceptable.

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\*Credits to be arranged, 3 per semester.

†Credits to be arranged, 1 per semester.

## PHILOSOPHY

### PHILOSOPHY (PHIL.)

406. MEDIEVAL PHILOSOPHY (3)  
410. STUDIES IN GREEK PHILOSOPHY (3-6)  
411. STUDIES IN MODERN PHILOSOPHY (3-6)  
414. AESTHETIC THEORY (3)  
417. NINETEENTH CENTURY PHILOSOPHY (3)  
418. RECENT AND CONTEMPORARY PHILOSOPHY (3)  
419. PHILOSOPHICAL BACKGROUNDS OF AMERICAN THOUGHT (3)  
425. PHILOSOPHY OF LAW (3)  
426. METAPHYSICS (3)  
427. ADVANCED ETHICS (3)  
428. (Math. 428). LOGICAL THEORY (3)  
429. SEMANTICS: PHILOSOPHY OF LANGUAGE AND SYMBOLISM (3)  
430. PHILOSOPHICAL PROBLEMS (3-6)
500. ETHICS: HISTORICAL AND SYSTEMATIC (2-6) Critical study of some phase of ethical theory, or of some period of the history of ethics.
504. SOCIAL AND POLITICAL PHILOSOPHY (3) Critical study of basic problems in their historical and functional setting.
505. IDEALS OF WESTERN CIVILIZATION (3) Analysis of contemporary ideals in terms of their Graeco-Judean bases.
506. SEMINAR IN ANCIENT PHILOSOPHY (3-6) Study of one or more important men or movements in ancient philosophy.
507. SEMINAR IN MEDIEVAL PHILOSOPHY (3-6) Study of one or more important men or movements in medieval philosophy.
508. SEMINAR IN MODERN PHILOSOPHY (3-6) Men and movements in philosophy from the Renaissance through the 19th century.
509. SEMINAR IN CONTEMPORARY PHILOSOPHY (3-6) Men and movements in 20th century philosophy.
510. CLASSICS OF SCIENTIFIC METHOD (3-6) Actual reasoning and procedures of historical masters of scientific methods.
511. PRINCIPLES OF EXPERIMENTAL INFERENCE (3-6) Science as controlled inquiry; types of scientific procedures in formal, physical, and sociocultural science.
514. SEMINAR IN 19TH CENTURY PHILOSOPHY (3) Study of a philosopher or philosophical movement of the 19th century.
515. PHILOSOPHICAL METHOD (3) Methods proposed by classical and contemporary thinkers for reaching philosophical conclusions: deductive, inductive, dialectical, pragmatic, intuitive.
530. PHILOSOPHY RESEARCH SEMINAR (3-6) Study of selected philosophical problems with an emphasis on techniques of philosophical research.
- 550-551. (Phil. 550-551). FOUNDATIONS OF MATHEMATICAL LOGIC (3 each) The nature of logical basis of mathematics; critical examination and development of the basic parts of logical calculus. Prerequisite: Math. 480 or Math. (Phil.) 428.
554. (Math. 554). METAMATHEMATICS (3) Prooftheoretic and modeltheoretic study of systems: Gödel's theorem, relative and absolute consistency proofs, decidability, properties of relational structures, mathematical applications. Prerequisite: Phil. (Math.) 428.
556. (Math. 556). RECURSION THEORY (3) Recursive functions; recursive and recursively enumerable sets; equivalent formulations of computability; Church's thesis; related topics from current literature. Prerequisite: Phil. (Math.) 428.



# PHYSICAL EDUCATION

JOHN D. LAWOTHER

*Associate Dean of the College of Physical Education and Athletics*  
246 Recreation Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Bedenk, Conger, Coombs, Davis, Gross, Harnett, Lawther, Speidel, and Thiel; Associate Professor Lucey.

Areas of specialization include: (1) history, philosophy, and principles; (2) applied science (physiology of exercise, kinesiology, body mechanics); (3) organization and administration; (4) objectives, programs, methods, and evaluation; (5) adaptives and correctives; (6) health; and (7) athletics, intramural and interschool. The master's candidate is expected to acquire a basic minimum of knowledge in each of these areas with little specialization except for his thesis or problem. The doctoral candidate is expected to focus on one area during his final year of graduate work.

The requirements for admission to the M.Ed. program are 24 semester hours in professional health and physical education and 24 in education and psychology, including general psychology, educational psychology, principles and methods of teaching, education electives, and practice teaching.

The requirements for admission to the M.S. program are 36 semester hours in professional health and physical education and 18 in education and psychology. An excellent background in the biological and physical sciences may satisfy up to half of the requirement in professional health and physical education.

## PHYSICAL EDUCATION (PH ED)

### 441. ADVANCED COACHING OF ATHLETICS FOR MEN (1 per unit)

- |                             |                        |
|-----------------------------|------------------------|
| Unit A. Basketball (1)      | Unit G. Swimming (1)   |
| Unit B. Football (1)        | Unit H. Gymnastics (1) |
| Unit C. Track and Field (1) | Unit I. Boxing (1)     |
| Unit D. Baseball (1)        | Unit J. Lacrosse (1)   |
| Unit E. Wrestling (1)       | Unit K. Fencing (1)    |
| Unit F. Soccer (1)          |                        |

### 449. ADVANCED TEACHING OF SPORTS AND RHYTHMICS (1 per unit)

- |                                                 |                                                                       |
|-------------------------------------------------|-----------------------------------------------------------------------|
| Unit A. Soccer and Speedball (1)                | Unit H. Early American Country<br>Dancing and Social Danc-<br>ing (1) |
| Unit B. Basketball (1)                          |                                                                       |
| Unit C. Field Hockey (1)                        | Unit I. Tennis (1)                                                    |
| Unit D. Archery (1)                             | Unit J. Badminton (1)                                                 |
| Unit E. Swimming (1)                            | Unit K. Golf (1)                                                      |
| Unit F. Rhythmics for Children (1)              |                                                                       |
| Unit G. Modern Dance and Accom-<br>paniment (1) |                                                                       |

### 452. ANALYSIS OF PHYSICAL EDUCATION ACTIVITIES FOR THE ELEMENTARY SCHOOL (3)

### 453. ANALYSIS OF PHYSICAL EDUCATION ACTIVITIES FOR THE HIGH SCHOOL (3)

### 454. THE NATURAL PROGRAM OF PHYSICAL EDUCATION ACTIVITIES, APPLIED (3)

### 455. SCIENTIFIC METHOD IN HEALTH AND PHYSICAL EDUCATION (3)

### 460. METHODS AND PRINCIPLES OF ATHLETIC COACHING (3)

### 480. ADVANCED ANATOMY AND PHYSIOLOGY, APPLIED (3)

### 489. INTRAMURAL ATHLETICS (3)

### 490. INTRODUCTION TO TESTS AND MEASUREMENTS IN HEALTH AND PHYSICAL EDUCATION (3)

### 491. ORGANIZATION AND ADMINISTRATION OF HEALTH AND PHYSICAL EDUCATION IN SCHOOLS (3)

## PHYSICAL EDUCATION

500. PROBLEM IN PHYSICAL EDUCATION (3) Prerequisite: Ph.Ed. 455.
522. ORGANIZATION AND ADMINISTRATION OF PHYSICAL EDUCATION IN COLLEGES AND UNIVERSITIES (3) Administration of physical education in college; credits, schedules, excuses, records, reports, budgets, classification, tests, staff, and facilities. Prerequisite: Ph.Ed. 491.
523. ADMINISTRATION OF COLLEGE ATHLETICS (3) Eligibility, schedules, managerial systems, relationships of athletics to the physical education program and to education in general. Prerequisite: Ph.Ed. 491.
526. ATHLETIC PROBLEMS IN SCHOOLS (3) Practical problems which result from administration of athletics in schools. Reports on some aspects of athletics required. Prerequisite: Ph.Ed. 460.
528. PROFESSIONAL EDUCATION OF TEACHERS OF HEALTH AND PHYSICAL EDUCATION (3) Health and physical education surveys, publicity, sociability and personality tests, legislation, state certification, standards for facilities and equipment, in-service, follow-up, and teacher-community problems. Prerequisite: Ph.Ed. 491.
529. SUPERVISION OF PHYSICAL EDUCATION IN SCHOOLS (3) Methods and policies of the school supervisor of physical education; conferences, planning and presenting the program, evaluating results, improving teachers-in-service, supervision of the classroom teacher. Prerequisite: Ph.Ed. 491.
530. RESEARCH TECHNIQUES IN HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (3) Prerequisite: Ph.Ed. 490.
531. RESEARCH IN HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (3) Prerequisite: Ph.Ed. 530.
532. TESTS AND MEASUREMENTS IN PHYSICAL EDUCATION (3) Critical study of tests and measurements available in physical education; methods of constructing and evaluating new tests and measurements. Prerequisite: Ph.Ed. 490.
534. STUDIES IN CURRICULUM CONSTRUCTION IN PHYSICAL EDUCATION (3) Principles and methods of curriculum building in physical education; different psychological and educational points of view, organizing a course of study committee, making units of instruction. Prerequisite: Ph.Ed. 454.
535. MODERN FOREIGN SYSTEMS OF PHYSICAL EDUCATION (3) Comparative analysis of national and local programs and systems of physical education in foreign countries. Prerequisites: Ph.Ed. 534, 595.
536. SCIENTIFIC METHODS IN ATHLETIC COACHING (3) Unusual techniques in athletic coaching which are not commonly recognized and used; advanced skills and strategy in coaching major sports. Prerequisite: Ph.Ed. 460.
550. SEMINAR IN HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (1-6)
555. RELATIONSHIPS OF PHYSICAL EDUCATION TO THE EXACT SCIENCES (3)
560. ADMINISTRATIVE PROBLEMS OF PHYSICAL EDUCATION IN SCHOOLS (3) Solutions to problems emerging from the administration of physical education in schools, fitting physical education into the school's schedule, awards and budgets. Prerequisite: Ph.Ed. 491.
581. PROBLEMS IN BODY MECHANICS (3) Certain aspects of human motion and body segmental alignment; analysis of human gait, and the dynamic adaptation of the spine, thorax, and pelvis to external physical forces. Prerequisites: Hl.Ed. 244, Ph.Ed. 399.
595. PHILOSOPHY OF HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (3) Prerequisite: Ph.Ed. 491 or Rc.Ed. 465.



# PHYSICAL SCIENCE

HENRY W. KNERR

*Chairman of the Committee on Physical Science*  
104 Willard Building

*Degrees Conferred:* D.Ed., M.Ed.

The M.Ed. program, which is designed to meet the needs of secondary school science teachers, consists of at least 24 credits chosen from chemistry, earth sciences, mathematics, and physics and a minor of at least 6 credits in educational foundations. A candidate is expected to complete at least one course in each of the four sciences and at least 12 credits in chemistry, earth sciences, or physics.

As a minimum requirement for admission a student is expected to have had 10 credits in chemistry, 8 credits in physics, mathematics through trigonometry, and 18 credits in education and related psychology.

## PHYSICS

JOHN A. SAUER, *Head of the Department*  
101 Osmond Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Ackerman, Fitzgerald, Gibbons, Knerr, Müller, Pepinsky, Rank, Sauer, Schilling, Stoner, and Webb; Associate Professors Bauer, Blanchard, Burnett, McCubbin, Myers, Okaya, Pratt, Rix, Roy, Vand, Weber, Wiggins, Winter, Woodward, and Work; Assistant Professors Bakamjian, Donahue, Goldburg, McCammon, and Signell.

Graduate instruction and research opportunities are available in visible and infrared spectroscopy, crystal structure, solid state, field emission, acoustics, high-pressure physics, biophysics, electronics, shock waves, low-temperature physics, nuclear physics, physics of high polymers, and various phases of theoretical physics.

A bachelor's degree in physics or an allied field is required for admission. Students who lack some of the usual upper-class undergraduate courses in physics may be requested to take additional course work without degree credit.

### PHYSICS (PHYS)

- 400. INTERMEDIATE ELECTRICITY AND MAGNETISM (4)
- 402. ELECTRONICS (4)
- 404. ELECTRONIC MEASUREMENTS (2-4)
- 406. NUCLEAR PHYSICS (3)
- 411. THEORETICAL MECHANICS (3)
- 412. THEORY OF THE SOLID STATE (3)
- 417. THE TEACHING OF PHYSICS (3)
- 420. INTERMEDIATE HEAT (3)
- 433. MECHANICS AND FLUID PHYSICS FOR TEACHERS (3)
- 435. ELECTRICITY AND MAGNETISM FOR TEACHERS (3)
- 436. OPTICS FOR TEACHERS (3)
- 437. HEAT, WAVE MOTION, AND SOUND FOR TEACHERS (3)



## PHYSICS

439. ELEMENTARY SURVEY OF MODERN PHYSICS FOR TEACHERS (3)
441. DEMONSTRATION EXPERIMENTS FOR TEACHERS (3)
443. INTERMEDIATE ACOUSTICS (3)
444. MEASUREMENTS IN ACOUSTICS (2)
454. ATOMIC AND NUCLEAR PHYSICS (3)
456. ATOMIC AND NUCLEAR PHYSICS (3)
457. EXPERIMENTAL ATOMIC PHYSICS (2)
458. INTERMEDIATE OPTICS (4)
461. THEORETICAL MECHANICS (3)
467. INTERMEDIATE ELECTRICITY AND MAGNETISM (3)
470. SPECIAL TOPICS (1-9)
- 473-474. BIOPHYSICS (3 each)
477. X-RAY ANALYSIS OF SOLIDS AND LIQUIDS (3)
  
507. THERMODYNAMICS AND KINETIC THEORY (3) Classical and modern thermodynamics; introduction to statistical mechanics.
509. PHYSICS SEMINAR (1-3 per semester) Topics from current research.
- 512-513. SOLID STATE PHYSICS (3 each) Analytical treatment of physical properties of solids: crystal structure, X-ray diffraction, lattice vibrations, paramagnetism, ferromagnetism, ferroelectricity; electron theory of metals, semiconductors. Prerequisite: Phys. 530.
517. STATISTICAL MECHANICS (3) Classical and quantum statistics, theory of ensembles, degenerate gases, applications to low temperature effects and co-operative phenomena. Prerequisites: Phys. 507, 561.
521. CRYSTAL STRUCTURE (3) Crystal symmetry, X-ray scattering, theory and techniques of crystal structure determination.
522. ADVANCED CRYSTAL ANALYSIS (3) Phase-determining methods in crystal analysis.
530. THEORETICAL MECHANICS (4) Newtonian mechanics; Lagrange's equations, Hamilton's principle; Hamilton's equations; coupled systems; waves in strings, central field problem; rigid bodies; elasticity; hydrodynamics.
532. ADVANCED THEORETICAL MECHANICS (3) Least action principle; canonical transformation; Lagrange and Poisson brackets; Hamilton-Jacobi equations; classical theory of fields. Prerequisite: Phys. 530.
533. THEORETICAL ACOUSTICS (3) Vibrating systems; transmission of disturbances through elastic and visco-elastic media. Prerequisite: Phys. 530.
- 553-554. NUCLEAR PHYSICS (3 each) Discussion and theoretical interpretation of basic experiments involving atomic nuclei and nuclear radiations. Prerequisite: Phys. 562.
557. ELECTRICITY AND MAGNETISM (3) Electro- and magnetostatics, Maxwell's equations, boundary value problems, electric and magnetic properties of material media.
558. ADVANCED ELECTRICITY AND MAGNETISM (3) Energy and momentum in the field, radiation theory, classical relativistic electron theory. Prerequisite: Phys. 557.
560. RESEARCH PROBLEMS (1-18) Introduction to research through individual assignments.

- 561-562. **QUANTUM MECHANICS** (3 each) The basic theory of wave and matrix mechanics, approximation methods, applications. Prerequisite: Phys. 530.
- 563-564. **ADVANCED QUANTUM MECHANICS** (3 each) Relativistic wave equations, quantum field theory, other advanced quantum theoretical topics. Prerequisite: Phys. 562.
565. **REACTOR ANALYSIS** (4) Physical principles and mathematical methods of reactor analysis. Prerequisite: Phys. 406.
566. **REACTOR ANALYSIS** (3) Continuation of Phys. 565. Prerequisite: Phys. 565.
571. **ATOMIC PHYSICS** (3) Experimental basis of modern physics; atomic spectra and structure, nuclear phenomena.
572. **SELECTED TOPICS IN SPECTROSCOPY** (3) Atomic and molecular spectra, experimental methods and theoretical analyses.
575. **SPECIAL TOPICS** (1-3 per semester) Theoretical studies in any field of modern physics with or without associated experimental work. Prerequisite: Phys. 456.

## PLANT PATHOLOGY

J. E. LIVINGSTON

*Head of the Department of Botany and Plant Pathology*  
206 Buckhout Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Fergus, Kneebone, Lewis, Livingston, Mills, and Wernham; Associate Professors Bloom, Boyle, Couch, and Graham; Assistant Professors Schein, Stambaugh, and Tammen.

A student may specialize in the study of plant diseases caused by fungi, bacteria, or viruses, and/or in their control, especially by plant breeding or by chemical means.

For admission a student must present at least 27 credits in botany, plant pathology, and biological science, of which not more than 6 may be in biological science. As many as 6 credits may be made up as undergraduate deficiencies after the candidate has been admitted to the Graduate School.

See also courses listed under botany, especially Bot. 419, 421, 501, 522, 523, and 526.

### PLANT PATHOLOGY (P PATH)

- |                                                                                                                                                                                                                                                |                          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| 404. DISEASES OF FIELD AND FORAGE CROPS (3)                                                                                                                                                                                                    | Messrs. Schein and Couch |
| 408. PLANT PATHOLOGICAL TECHNIQUES (3)                                                                                                                                                                                                         | Mr. Bloom                |
| 412. ADVANCED FOREST PATHOLOGY (3)                                                                                                                                                                                                             | Mr. Fergus               |
| 419. (Bot. 419). MYCOLOGY (3)                                                                                                                                                                                                                  | Mr. Fergus               |
| 425. DISEASES OF ORNAMENTAL AND FLORICULTURAL PLANTS (3)                                                                                                                                                                                       | Mr. Tammen               |
| 428. DISEASES OF FRUIT AND VEGETABLE CROPS (3)                                                                                                                                                                                                 | Mr. Bloom                |
|                                                                                                                                                                                                                                                |                          |
| 501. CLINICAL PLANT PATHOLOGY (3) Advanced course in diagnostic techniques to acquaint the students with specialized procedures for field and laboratory identification of plant diseases. Prerequisites: P.Path. 10, 408, P.Path. (Bot.) 419. | Mr. Couch                |

## PLANT PATHOLOGY

509. PRINCIPLES OF PLANT INFECTION (3) Physiological processes of plant pathogenic bacteria and fungi occurring during incubation, ingress, and infection. Prerequisites: P.Path. 10 or 11, P.Path. (Bot.) 419. Spring semester, odd years.  
*Mr. Schein*
515. DISEASE RESISTANCE IN PLANTS (2-4) Stability of resistance, selection of resistant material, economics of control, special problems. Prerequisites: Bot. (Zool.) 22 or 33, P.Path. 10. Fall semester, odd years. *Messrs. Wernham and Mills*
519. VIRUS DISEASES OF PLANTS (3) Nature, symptomatology, transmission, and control of virus diseases of plants. Fall semester, even years. *Mr. Boyle*
520. PLANT PATHOGENIC BACTERIA (3) Bacteria causing plant diseases; methods of identification, inoculation, and control. Spring semester, odd years.  
*Mr. Kneebone*
522. (Bot. 522). MYXOMYCETES, PHYCOMYCETES, AND ASCOMYCETES (4) Morphology, taxonomy, phylogeny, and life histories; identification and field work. Prerequisite: P.Path. (Bot.) 419. Fall semester, odd years. *Mr. Fergus*
523. (Bot. 523). BASIDIOMYCETES AND FUNGI IMPERFECTI (4) Morphology, taxonomy, phylogeny, and life histories. Prerequisite: P.Path. (Bot.) 419. Spring semester, even years. *Mr. Fergus*
530. PLANT DISEASE CONTROL (3) Methods, and laboratory and field testing of materials used in plant disease control. Spring semester, even years.
531. PLANT PATHOLOGY SEMINAR (1 per semester) Selected topics of current research, history, and contemporary trends in plant pathology.

## POLITICAL SCIENCE

ELTON ATWATER, *Head of the Department*  
129 Sparks Building

*Degrees Conferred:* Ph.D., M.A., M.P.A.

*Graduate Faculty:* Professors Atwater, Brewster, Ferguson, McGeary, Riemer, and Silva; Associate Professors Aspaturian and Monat; Assistant Professor Sorauf; Mr. Albinski.

Students may specialize in American government, public administration, political theory, international relations, or comparative government.

Applicants for admission to the M.A. and Ph.D. programs will be expected to have at least 12 credits in political science or its equivalent. In exceptional cases students may be permitted to make up deficiencies after beginning their graduate programs.

Candidates for the M.P.A. must present for admission, or make up without graduate credit, at least 6 credits in political science and at least 3 credits in each of the following fields: economics, public finance, accounting or statistics, and psychology.

Requirements for the M.P.A. degree include Econ. 423, Pl.Sc. 445, and Pl.Sc. 570-580, inclusive.

### POLITICAL SCIENCE (PL SC)

401. POLITICAL BEHAVIOR (3)  
411. AMERICAN POLITICAL THEORY (3)

*Mr. Sorauf*  
*Mr. Riemer*



# POLITICAL SCIENCE

413. GOVERNMENT AND POLITICS OF THE SOVIET UNION (3) *Mr. Atwater*
414. FOREIGN POLICY OF THE SOVIET UNION (3) *Mr. Aspaturian*
415. INTERNATIONAL ORGANIZATION (3-6) *Mr. Aspaturian*
416. INTERNATIONAL LAW (3) *Mr. Aspaturian*
417. MUNICIPAL GOVERNMENT (3)
419. PUBLIC ADMINISTRATION (3) *Mr. McGeary*
421. MODERN POLITICAL THEORY (3) *Mr. Riemer*
424. AMERICAN STATE AND LOCAL GOVERNMENT AND ADMINISTRATION (3) *Mr. Monat*
426. POLITICAL PARTIES (3) *Miss Silva*
427. PUBLIC OPINION AND PROPAGANDA (3) *Miss Silva*
431. ANCIENT AND MEDIEVAL POLITICAL THEORIES (3) *Mr. Riemer*
432. CURRENT POLITICAL TRENDS AND PROBLEMS IN THE UNITED STATES (3-9) *Messrs. Riemer and Sorauf, Miss Silva*
433. THE LAW OF LABOR-MANAGEMENT RELATIONS (3) *Mr. Brewster*
442. AMERICAN FOREIGN POLICY (3) *Mr. Atwater*
444. GOVERNMENT REGULATION (3) *Mr. Ferguson*
445. ADMINISTRATIVE LAW (3) *Mr. Brewster*
446. JUDICIAL SYSTEMS (3)
450. GOVERNMENTS AND FOREIGN POLICIES OF THE COMMONWEALTH OF NATIONS (3) *Mr. Albinski*
451. COMPARATIVE GOVERNMENT (3) *Mr. Albinski*
456. GOVERNMENTS AND FOREIGN POLICIES OF LATIN AMERICA (3)
458. GOVERNMENTS AND FOREIGN POLICIES OF THE FAR EAST (3-6) *Mr. Aspaturian*
499. FOREIGN STUDY IN GOVERNMENT (2-6)
500. SEMINAR IN POLITICAL SCIENCE (3-12) Subject to be announced. *Mr. Brewster*
505. SEMINAR IN ADVANCED AMERICAN GOVERNMENT (3-12)
509. RESEARCH TECHNIQUES IN POLITICAL SCIENCE (3) *Miss Silva*
512. COMPARATIVE GOVERNMENT (3-12) *Mr. Albinski*
515. INTERNATIONAL RELATIONS (3-6) *Mr. Atwater*
517. INTERNATIONAL ORGANIZATION (3-6) *Mr. Aspaturian*
519. PUBLIC ADMINISTRATION (3-6) *Mr. McGeary*
521. POLITICAL THEORY (3-6) *Mr. Riemer*
535. GOVERNMENT REGULATION (3-6)
570. CURRENT TRENDS AND PROBLEMS IN ADMINISTRATION (3-6) *Mr. Ferguson*
571. THEORY OF PUBLIC MANAGEMENT (3-6) The role of the executive in modern government; the objectives of public administration; theories of administrative organization and practice.
572. INTERNATIONAL ADMINISTRATION (3-6) The execution of foreign policies through national and international public and private organizations.
575. PUBLIC PERSONNEL ADMINISTRATION (3) Government personnel systems; current trends and problems; essentials of recruitment, classification and pay, ratings, supervision, training, and discipline.

576. PUBLIC FISCAL ADMINISTRATION (3) The role of the executive in fiscal planning; budget preparation; expenditure control; tax assessment and collection; investment of public funds. *Mr. Monat*
577. PUBLIC ORGANIZATION AND METHODS (3) Principles of government organization; management surveys; work measurement; methods of achieving efficiency and economy.
578. PUBLIC PLANNING AND ZONING (3) Public planning agencies and their functions; essentials of effective planning and zoning; current trends and problems.
580. INTERNSHIP IN PUBLIC ADMINISTRATION (6)

## POULTRY HUSBANDRY

ARTHUR J. G. MAW, *Head of the Department*  
103 Weaver Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Bressler, Margolf, Maw, and Murphy; Associate Professors Buss, Hale, Mueller, and Schein.

Students may specialize in poultry nutrition, poultry management, poultry products, poultry breeding, or animal behavior. In each area the program consists of a joint major between the Department of Poultry Husbandry and one or more basic science departments. Admission requirements vary according to the area of specialization. Students with undergraduate majors in the basic sciences may qualify.

Excellent facilities are available for research in production, processing, and preservation of market eggs and dressed poultry, and in chick and poult nutrition. A specially designed and equipped Solar Laying House also provides facilities for investigation of production and behavioral problems encountered in large, concentrated populations of layers.

### POULTRY HUSBANDRY (P H)

401. (Psy. 401, Zool. 401). ANIMAL BEHAVIOR (3) *Mr. Hale*
402. SPECIAL TOPICS (3-12)
502. ADVANCED POULTRY NUTRITION (2-4) *Mr. Murphy*
503. ADVANCED POULTRY FARM MANAGEMENT (2-4) *Mr. Bressler*
504. ADVANCED MARKET POULTRY AND EGGS (2-4) Prerequisites: P.H. 1, 7; Ag.Ec. 33 or 2 additional credits in poultry husbandry. *Messrs. Margolf and Mueller*
505. RESEARCH IN POULTRY HUSBANDRY (1-15 per semester) Prerequisite: 9 credits in poultry husbandry.
506. SEMINAR IN POULTRY HUSBANDRY (1-6)
582. (Psy. 582, Zool. 582). RESEARCH IN ANIMAL BEHAVIOR (2-6 per semester) Research in special areas of animal behavior involving field or laboratory work. Prerequisite: P.H. (Psy., Zool.) 401; or Psy. 403. *Messrs. Hale and Schein*

# PSYCHOLOGY

ARTHUR H. BRAYFIELD, *Head of the Department*  
112 Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Adams, Bernreuter, Brayfield, Carpenter, Corso, Grosslight, Guest, Guthrie, Hall, Harris, Lepley, Siegel, Smith, W. U. Snyder, and VanOrmer; Associate Professors Gorlow, Hale, Thevaos, and Whaley; Assistant Professors Ashby, Ford, Hoffman, Jackson, Piers, Prokasy, Helen Snyder, and Urban.

Areas in which a student may specialize are: (1) clinical psychology, which includes professional training for mental hygiene clinics, colleges, and institutions; (2) educational and developmental psychology, which prepares for college teaching, teacher education, and educational clinics; (3) experimental and general psychology, which prepares for college teaching and for academic and professional specialties; (4) school psychology, which prepares for work in the public schools and for the Pennsylvania State Certificate as a Public School Psychologist; (5) industrial and business psychology, which prepares for positions in the application of psychology to business, industry, institutions, and state and federal agencies; (6) social psychology, which prepares for college teaching, work in applied social psychology—group dynamics, delinquency, attitude studies, and communications; and (7) psychological measurements and statistics, which provide basic skills for college teaching, work in admission and evaluation programs, test publishing organizations, state and federal agencies, and for most of the areas listed above.

The Penn State Anechoic Chamber provides an exceptional facility for research in hearing for students in experimental and industrial psychology. The Psychology Clinic offers unique training in the clinical and counseling areas.

Requirements for admission include a broad undergraduate preparation, a junior-senior scholastic average of B, a minimum of 12 credits in psychology, and a satisfactory graduate student rating on a scholastic aptitude examination. Applicants with a master's degree will have their admission evaluated with emphasis on the quality of their graduate program.

## PSYCHOLOGY (PSY)

- |                                                                         |                |
|-------------------------------------------------------------------------|----------------|
| 400. HONORS COURSE IN PSYCHOLOGY (2-6)                                  |                |
| 401. (P.H. 401, Zool. 401). ANIMAL BEHAVIOR (3)                         | Mr. Hale       |
| 403. INTRODUCTORY PHYSIOLOGICAL PSYCHOLOGY (3)                          |                |
| 411. PSYCHOLOGY OF THE PRESCHOOL CHILD (3)                              |                |
| 412. ABNORMAL PSYCHOLOGY (3)                                            |                |
| 414. INTERMEDIATE EDUCATIONAL PSYCHOLOGY (2-3)                          | Miss H. Snyder |
| 415. INTERMEDIATE STATISTICS IN PSYCHOLOGY AND EDUCATION (3)            |                |
| 417. SOCIAL PSYCHOLOGY (2-3)                                            |                |
| 418. MEASUREMENT OF PERSONALITY (3)                                     |                |
| 419. GUIDANCE AND EDUCATION IN SEXUAL AND MARITAL ADJUSTMENT (3)        | Mr. Adams      |
| 420. APPLIED SOCIAL PSYCHOLOGY (3)                                      |                |
| 422. PSYCHOLOGICAL METHODS OF MEASURING THE REACTIONS OF THE PUBLIC (3) | Mr. Guest      |
| 423. TEST CONSTRUCTION AND STANDARDIZATION (2-3)                        |                |
| 425. PSYCHOLOGY OF THE ELEMENTARY SCHOOL CHILD (2-3)                    | Mr. Whaley     |
| 426. ADOLESCENCE (2-3)                                                  | Mr. Harris     |
| 427. PSYCHOLOGICAL PRINCIPLES IN ADVERTISING (3)                        | Mr. Guest      |
| 428. OPINION RESEARCH LABORATORY (3)                                    | Mr. Guest      |



## PSYCHOLOGY

429. PSYCHOLOGY OF COMMUNICATION (3)
  431. INDUSTRIAL PSYCHOLOGY (3) *Mr. Smith*
  432. INTRODUCTORY ENGINEERING PSYCHOLOGY (3) *Mr. Corso*
  433. PSYCHOLOGY OF OCCUPATIONAL BEHAVIOR (2)
  436. MENTAL HYGIENE IN SCHOOLS (3) *Mr. Gorlow*
  437. PSYCHOLOGY OF ADJUSTMENT (3) *Mr. Gorlow*
  438. THEORY OF PERSONALITY (3) *Mr. Jackson*
  440. PSYCHOLOGY PROJECTS (1-6)
  441. INDUSTRIAL MOTIVATION AND MORALE (3)
  445. (C.D.F.R. 445). DEVELOPMENT THROUGHOUT ADULTHOOD (3)
  450. MEASUREMENT OF ABILITIES (3)
  474. PSYCHOLOGY OF EXCEPTIONAL CHILDREN (3) *Miss Piers*
  482. INTRODUCTION TO CLINICAL PSYCHOLOGY (3)
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500. SEMINAR INTRODUCTION TO GRADUATE STUDY (0) For all new graduate students in psychology. *Mr. Brayfield*
  501. ADVANCED PSYCHOLOGY (3) Comprehensive study of general psychology. Prerequisite: 9 credits in psychology. *Mr. Lepley*
  502. ADVANCED EDUCATIONAL PSYCHOLOGY (2-4) Psychological theories and principles underlying educational theories and practices. Prerequisites: Psy. 14 or 414; practice teaching or teaching experience.
  503. PHYSIOLOGICAL PSYCHOLOGY (2-6) Correlations between structure and function of nervous system and human consciousness; laws and theories in fields of sensation, attention, association, affection, and thought. Prerequisite: 9 credits in psychology.
  504. COMPARATIVE PSYCHOLOGY (2-4) Behavior from standpoint of phylogenetic growth and development; biological implications; comparison of different types of animals, including man. Prerequisite: 9 credits in psychology. *Mr. Hale*
  505. RESEARCH PROBLEMS IN PSYCHOLOGY (1-15) Prerequisite: 12 credits in psychology.
  509. ADVANCED THEORY OF LEARNING AND HABIT FORMATION (2-3) Critical evaluation of major theories of learning: Hull, Guthrie, Tolman, Lewin. Application of learning theory to major problems in psychology. Prerequisite: Psy. 4 or 414. *Mr. Grosslight*
  510. HISTORY OF PSYCHOLOGY (3) Theoretical systems, experiments, and personalities in development of modern psychology until about 1920. Prerequisite: 9 credits in psychology. *Mr. Corso*
  511. CONTEMPORARY AMERICAN PSYCHOLOGY (2-3) Current systems or schools of psychology with comparative study and critical analysis; points of view as presented by recognized leaders. Prerequisite: 9 credits in psychology. *Mr. Hall*
  513. EDUCATIONAL PSYCHOLOGY: DIFFERENTIAL (3) Causes of differences in achievement and personality; psychological implications of methods used by schools in adjusting to individual differences. Prerequisites: Psy. 14 or 414; 6 credits at 400 level in psychology.
  514. EDUCATIONAL PSYCHOLOGY: LEARNING (2) Experimentally determined facts about the learning process; synthesis of main theories of learning; application of principles related to: motivation, practice, retention, transfer, meaning, and problem solving. Prerequisites: Psy. 14 or 414; 6 credits at 400 level in psychology.

515. ADVANCED STATISTICS IN PSYCHOLOGY AND EDUCATION (3) Correlation theory and methods, discriminant function, and factor analysis; applications to mental test theory. Prerequisite: Psy. 415 or Ed.Ser. 590.
516. THEORIES OF DECISION-MAKING (3) Theoretical models and experimental evidence concerning choice behavior, strategies, and values, under riskless conditions and under uncertainty and risk. *Mr. Siegel*
517. PSYCHOLOGY OF ATTITUDES AND OPINIONS (3) Acquisition and control of attitudes and opinions, including beliefs, convictions, biases, prejudices, and ideologies as determinants of action. Prerequisite: 18 credits in psychology, including Psy. 417, 422, 437.
518. PROJECTS IN EXPERIMENTAL PSYCHOLOGY (2-4) Individual experimental projects; seminars on experimental design and instrumentation.
522. SURVEY RESEARCH TECHNIQUES (3) Sample and questionnaire designs for investigation of consumer reactions and social issues, and appropriate analytic procedures. Prerequisite: 3 credits in statistics. *Mr. Guest*
527. STATISTICAL INFERENCE AND EXPERIMENTAL DESIGN (3) Probability theory, sampling distributions, analysis of variance and covariance, analysis of trend, non-parametric statistics, experimental design. Prerequisite: Psy. 415 or Ed.Ser. 590.
528. OPINION RESEARCH ADMINISTRATION (3-6) Practicum in planning, development of techniques, and administration of the sample survey. Prerequisites: Psy. 15, 21, 422. *Mr. Guest*
529. (C.D.F.R. 529). SEMINAR IN CHILD DEVELOPMENT (1-6) Readings and reports on recent findings in child development. Prerequisite: 6 credits in child development or 6 in educational or child psychology, plus 3 in statistics.
534. ADVANCED ENGINEERING PSYCHOLOGY (3) Experimental studies of psychological factors affecting design and operation of machines. Prerequisites: Psy. 3 and 4, or Psy. 432 or 501. *Mr. Corso*
535. HUMAN DEVELOPMENT (2-3) Psychological phases of human development throughout the life span; implications for school, community, and home. Prerequisite: 9 credits in psychology. *Messrs. VanOrmer and Whaley*
536. RESEARCH METHODS AND PROBLEMS IN EDUCATIONAL AND DEVELOPMENTAL PSYCHOLOGY (1-6) Prerequisites: Psy. 414 or 514; Ed.Ser. 490 or Psy. 415. *Mr. Harris*
537. SEMINAR IN INDUSTRIAL PSYCHOLOGY (3) Prerequisite: Psy. 431. *Mr. Smith*
538. PSYCHOLOGY OF PERSONNEL DEVELOPMENT (3) Industrial training in relation to psychological learning theory and experimental findings. Prerequisite: Psy. 431 or 414. *Mr. Smith*
539. MOTIVATION AND EMOTION (3) Systematic status of instinct, drive, motive, will, purpose; methodology and results of physiological, experimental, and clinical investigation of basic drives. Prerequisite: Psy. 503. *Mr. Hall*
540. SEMINAR IN CLINICAL PROBLEMS (1-6) Contemporary psychological theory, research, and methodology in relation to clinical psychology. Prerequisites: Psy. 542, 560.
541. PERSONALITY THEORY (3-4) Contemporary theories of personality and relevant research with emphasis upon normal processes. Prerequisite: Psy. 438. *Mr. Gorlow*



## PSYCHOLOGY

542. PSYCHOPATHOLOGY (3-4) Theories of pathological behavior with reference to clinical and experimental data. Prerequisites: Psy. 412, 541. *Mr. Urban*
543. SURVEY OF COUNSELING AND PSYCHOTHERAPY (3) Critical analysis of important systems of psychotherapy; history, rationale, and method. Prerequisite: Psy. 541. *Mr. Ford*
551. THEORY AND PRACTICUM IN CLINICAL APPRAISAL OF ABILITIES AND INTELLIGENCE I (3-4) Theories of intellectual behavior; introduction to clinical testing with emphasis on individual intelligence tests. Prerequisites: Psy. 450, 482; or 15 credits in psychology. *Miss Piers*
552. THEORY AND PRACTICUM IN CLINICAL APPRAISAL OF ABILITIES AND INTELLIGENCE II (3) Theory, development of tests, and research in intellectual assessment; practicum experience with institutionalized subjects. Prerequisite: Psy. 551. *Miss Piers*
553. ADVANCED THEORY OF CLINICAL ASSESSMENT (3) Problems in clinical assessment of cognitive functioning, such as assessment of brain injury, aphasic behaviors, etc. Prerequisites: Psy. 542, 552.
555. THEORY AND PRACTICUM IN CLINICAL ASSESSMENT OF PERSONALITY (3) Theoretical issues and research in clinical assessment with special reference to administration and interpretation of projective methods. Prerequisites: Psy. 542, 552. *Messrs. Guthrie and Gorlow*
556. THEORY AND PRACTICUM IN CLINICAL ASSESSMENT OF PATHOLOGICAL SYNDROMES (3) Current research and theoretical issues in the clinical assessment of pathological syndromes; includes practicum. Prerequisite: Psy. 555. *Messrs. Guthrie and Gorlow*
557. ADVANCED PERSONALITY ASSESSMENT (3) Personality and measurement theories related to problems of prediction, diagnosis, and research. Prerequisite: Psy. 556. *Messrs. Guthrie and Gorlow*
560. PRACTICUM IN CLINICAL METHODS (3-6) Personality and vocational diagnostic evaluations and short-term counseling with adults and children. Prerequisites: Psy. 482, 541, 551.
561. CLINICAL PRACTICUM WITH CHILDREN (1-3) Diagnosis and counseling of child-parent problems of learning and adjustment; includes principles of school psychology. Prerequisite: Psy. 560. *Miss Piers*
564. THEORY AND PRACTICUM IN COUNSELING AND PSYCHOTHERAPY WITH ADULTS (3-6) Counseling with personal adjustment problems referred to the Psychology Clinic. Prerequisites: Psy. 543, 560. *Mr. Snyder*
567. THEORY AND PRACTICUM IN COUNSELING AND PSYCHOTHERAPY WITH CHILDREN (1-3) Practical experience in the Psychology Clinic in use of play therapy with young children; staff meetings; seminar on principles and techniques. Prerequisites: Psy. 543, 560, 564. *Miss Piers*
569. ADVANCED THEORY AND PRACTICUM IN COUNSELING AND PSYCHOTHERAPY (3-6) Practical experience in the Psychology Clinic in advanced nondirective therapy techniques; staff meetings; case conferences. Prerequisite: Psy. 564. *Mr. Snyder*
571. SOCIAL PSYCHOLOGY (3) Historical development of theory and methods; determinants and principles of complex social or interactional behavior; contemporary problems and research. Prerequisites: 3 credits in social psychology.



580. THEORY AND CONSTRUCTION OF ATTITUDE SCALES (3) Measurement of social, political, commercial, and industrial attitudes; questionnaire designs. Prerequisite: 3 credits in statistics.
582. (P.H. 582, Zool. 582). RESEARCH IN ANIMAL BEHAVIOR (2-6 per semester) Research in special areas of animal behavior involving field or laboratory work. Prerequisite: Psy. (P.H., Zool.) 401; or Psy. 403. *Messrs. Hale and Schein*
590. PROBLEMS IN CLINICAL RESEARCH (1-6) Prerequisite: Psy. 415.
591. SEMINAR ON TEACHING PSYCHOLOGY (1-3) Objectives and content of psychology; organization and presentation of material; teaching aids and techniques. *Mr. Whaley*

## RECREATION EDUCATION

FRED M. COOMBS, *in Charge of Recreation Education*  
244 Recreation Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

Students may prepare for recreation administrative positions in public recreation systems, industries, hospitals, camps, or private agencies; or for leadership of special groups in a particular activity. The areas for specialization include: (1) history, philosophy, and principles; (2) administration and supervision; (3) planning areas and facilities; (4) program content and application; (5) surveys and appraisals; (6) principles of the group process; and (7) research.

For admission an undergraduate major in recreation education is desirable; but a major in sociology, music, physical education, fine or industrial arts, theatre arts, or other related fields may be accepted.

Students who lack some of the prerequisite courses may be admitted but are required to make up the deficiency without degree credit.

### RECREATION EDUCATION (RC ED)

430. CAMPING AND OUTDOOR EDUCATION (3)
434. (L.Arch. 434). RECREATION AREAS AND FACILITIES (3)
456. SOCIAL RECREATION (3)
461. COMMUNITY RECREATION (3)
465. ADMINISTRATION OF RECREATION (3)
530. CAMP ADMINISTRATION (3) Camp site development; staff selection, training, and supervision; development of objectives and program planning; values inherent in outdoor and camping education. Prerequisite: Rc.Ed. 430.
533. RECREATION STUDIES, SURVEYS, AND APPRAISALS (3) Types, purposes, and methods of conducting recreation studies and surveys; procedures in appraisal of community recreation. Prerequisite: Ph.Ed. 530.
560. ADMINISTRATIVE PROBLEMS OF RECREATION (3) Administrative problems in park and recreation departments; departmental organization, finance, personnel, facilities, program, and public relations. Prerequisite: Rc.Ed. 465.

## ROMANCE LANGUAGES AND LITERATURES

FRANKLIN B. KRAUSS

*Head of the Department of Romance Languages*  
301 Sparks Building

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Professors Eyer, Hyslop, Krauss, and LeSage; Associate Professors Belasco, Bleznick, Brentin, Chapman, Moser, and Sturcken.

The minimum requirement for admission to an advanced degree program will normally be 24 credits of post-intermediate work in language and literature. A student concentrating in either French or Spanish may, if he wishes, choose the second area as a minor.

### FRENCH (FR)

- 400. FRENCH LITERATURE OF THE RENAISSANCE (3)
- 405. FRENCH LITERATURE IN THE ROMANTIC PERIOD (3)
- 406. FRENCH LITERATURE IN THE REALISTIC PERIOD (3)
- 411. FRENCH PROSE OF THE 20TH CENTURY (3)
- 413. CONTEMPORARY FRENCH DRAMA (3)
- 416. FRENCH POETRY AND DRAMA OF THE 20TH CENTURY (3)
- 421. THE TEACHING OF ROMANCE LANGUAGES (3)
- 431. FRENCH LITERATURE OF THE CLASSICAL PERIOD (3)
- 433. THE AGE OF ENLIGHTENMENT (3)
- 471. PROBLEMS IN FRENCH LITERATURE (3-6)
- 490. ADVANCED COMPOSITION AND CONVERSATION (3)

\*1G. ELEMENTARY FRENCH FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.

501. FRENCH DRAMA OF THE CLASSICAL PERIOD (3) Origins and developments of French classical comedy and tragedy, emphasizing the works of Corneille, Racine, and Molière.

549. SYMBOLISM (3) The anti-positivistic tradition in 19th century French literature dealing with the Symbolist School, its antecedents and its subsequent ramifications.

552. MEDIEVAL FRENCH LITERATURE (3) Familiarizes the student with Old and Middle French texts from the earliest monuments to Villon. Prerequisite: R.Ph. 551.

562. FRENCH THINKERS OF THE 18TH CENTURY (3)

570. VOLTAIRE AND ROUSSEAU (3)

571. SEMINAR IN FRENCH LITERATURE (3-12) Lectures on methods of research. Students will pursue common and individual investigations in fields selected after consultation with the instructor.

580. PROUST AND GIDE (3)

### ITALIAN (IT)

571. SEMINAR IN ITALIAN LITERATURE (3) Lectures on methods of research. Students will pursue common and individual investigations in fields selected after consultation with the instructor.

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\*No graduate credit is given for this course.

PORTUGUESE (PORT)

571. SEMINAR IN PORTUGUESE LITERATURE (3-6)

SPANISH (SPAN)

- 401. THE GOLDEN AGE (3)
- 402. DRAMA OF THE GOLDEN AGE (3)
- 403. DON QUIXOTE (3)
- 404. OLD SPANISH LANGUAGE AND LITERATURE (3)
- 405. SPANISH DRAMA OF THE 19TH CENTURY (3)
- 407. THE SPANISH NOVEL OF THE 19TH CENTURY (3)
- 408. THE CONTEMPORARY SPANISH NOVEL (3)
- 409. INTRODUCTION TO LATIN-AMERICAN LITERATURE (3)
- 410. INTRODUCTION TO LATIN-AMERICAN LITERATURE (3)
- 411. MEXICO: ITS LANGUAGE AND LITERATURE (3)
- 417. SPANISH LITERATURE IN THE ROMANTIC PERIOD (3)
- 421. THE TEACHING OF ROMANCE LANGUAGES (3)
- 471. PROBLEMS IN SPANISH LITERATURE (3-6)
- 490. ADVANCED COMPOSITION AND CONVERSATION (3)

\*1G. ELEMENTARY SPANISH FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.

- 501. GOLDEN AGE LITERATURE (3) Nature and development of Spanish literature of the 16th and 17th centuries.
- 538. THE GENERATION OF 1898 (3) Principal works and intellectual trends of the period with special emphasis on Unamuno.
- 549. MODERNISMO (3) The movement, its antecedents, and its followers, with special emphasis on Rubén Darío.
- 552. MEDIEVAL SPANISH LITERATURE (3) Familiarizes the student with Old Spanish texts.
- 565. LOPE DE VEGA (3)
- 567. CERVANTES AND HIS WORKS (3)
- 571. SEMINAR IN SPANISH LITERATURE (3-6) Lecture on methods of research. Students will pursue common and individual investigations in fields selected after consultation with the instructor.

ROMANCE LITERATURE (R LIT)

- 544. NEOCLASSICISM IN THE ROMANCE LITERATURES (3) The neoclassical movement in the Romance literatures, with emphasis on French and Spanish.
- 545. ROMANTICISM IN THE ROMANCE LITERATURES (3) The Romantic movement in the Romance literatures, with emphasis on French and Spanish.
- 546. MEDIEVAL ROMANCE LITERATURES (3) Medieval writings in the Romance literatures, with emphasis on French and Spanish.
- 547. REALISM IN THE ROMANCE LITERATURES (3) The Realistic movement in the Romance literatures, with emphasis on French and Spanish.

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\*No graduate credit is given for this course.



## ROMANCE LANGUAGES

554. THE RENAISSANCE IN THE ROMANCE LITERATURES (3) The effect of the Renaissance on the Romance literatures, with emphasis on French and Spanish.

### ROMANCE PHILOLOGY (R PH)

551. ROMANCE PHILOLOGY (3)  
558. ADVANCED LINGUISTICS AND PHONETICS OF THE ROMANCE LANGUAGES (3)  
573. THEORY AND TECHNIQUES OF TEACHING THE ROMANCE LANGUAGES (1-2)  
574. METHODS AND BIBLIOGRAPHY IN ROMANCE LANGUAGES AND LITERATURES (1-2)

## RURAL SOCIOLOGY

MACKLIN E. JOHN

*Head of the Department of Agricultural Economics and Rural Sociology*  
1 Weaver Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Bonser, Brown, Buck, and John; Associate Professors Bylund, Copp, and Nolan; Assistant Professors Fliegel and Freeman.

The entering student in the master's program should have as prerequisites 3 credits in rural sociology, 3 credits in sociology, and 3 additional credits in either field. If he does not have these prerequisites, he may take them at this University during the early part of his master's program.

### RURAL SOCIOLOGY (R SOC)

402. CONSUMER BEHAVIOR AND THE AGRICULTURAL INDUSTRY (3) *Mr. Bylund*  
452. RURAL ORGANIZATION (3) *Mr. Copp*  
459. RURAL SOCIAL PSYCHOLOGY (3) *Mrs. Nolan*  
  
501. DEVELOPMENT OF RURAL SOCIOLOGY (2) Historical development with emphasis on American rural sociology. *Mr. Buck*  
502. ADVANCED RURAL SOCIOLOGY (3) Structure and functioning of rural society; evaluation of theoretical systems.  
510. RURAL MIGRATION (2) Rural migration research and theory; application to governmental and community problems. *Mr. Buck*  
512. NATIONAL FARM ORGANIZATIONS (2) National farm organizations as social systems. Prerequisite: R.Soc. 452. *Mr. Copp*  
513. SOCIOLOGY OF CONSUMER BEHAVIOR (2) Sociological theory and research pertaining to consumer behavior. *Mr. Bylund*  
514. VALUES IN RURAL SOCIETY (2) Values as dynamic forces in rural society. *Mrs. Nolan*  
515. EXTENSION ORGANIZATION AND METHODS (2) Agricultural and home economics extension as a social system with emphasis on techniques of organization and program development. *Mr. Brown*  
516. CHANGE IN RURAL SOCIETY (2) Social change in rural society emphasizing prediction and control of the change process. *Mr. Fliegel*  
551. RURAL SOCIOLOGY SEMINAR (1-6) Prerequisite: 6 credits in rural sociology, sociology, or psychology.

# SANITARY ENGINEERING

(See page 76, Civil Engineering.)

## SECONDARY EDUCATION

JAMES H. MOYER, *Head of the Department*  
207A Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors McGarey, Moyer, Patrick, Remaley, and Veon; Associate Professors Fowler, Kozak, and Torkelson; Assistant Professors Page and Weiss.

Graduate degree programs in the department are provided primarily for the advanced preparation of competent public school teachers.

In general, candidates for the M.Ed. in secondary education must have 18 approved undergraduate credits in education and psychology including practice teaching in an area appropriate to the major, and aptitude for and interest in advanced professional preparation. Applicants are encouraged to have had at least two years of successful teaching experience.

While candidates are required to specialize in secondary education, they are encouraged to acquire a general education in the social sciences, the behavioral sciences, and the humanistic foundations.

The M.Ed. degree may be earned, in general, in those fields outside of secondary education for which a master's degree has been approved, provided such a professional program is appropriate. Thus, for example, the M.Ed. degree may be earned with a major in English or chemistry. These programs require an approved minor in educational foundations.

### SECONDARY EDUCATION (SEC ED)

- 400. THE SCIENTIFIC DIRECTION OF LEARNING ACTIVITIES (2-4)
- 426. TEACHING MATHEMATICS IN THE SECONDARY SCHOOL (3)
- 433. TEACHING SOCIAL STUDIES IN THE HIGH SCHOOL (2-3)
- 436. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE SECONDARY SCHOOL (3)
- 437. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE SECONDARY SCHOOL (3)
- 438. TEACHING SCIENCE IN SECONDARY SCHOOLS (2-3)
- 443. READING PROBLEMS IN THE SECONDARY SCHOOL (2-3)
- 453. TEACHING SECONDARY SCHOOL ENGLISH (2-3)
- 454. EXTRACURRICULAR ACTIVITIES IN THE JUNIOR AND SENIOR HIGH SCHOOL (2-3)
- 456. PRINCIPLES AND PROBLEMS IN BUSINESS EDUCATION (1-3)
- 459. IMPROVEMENT OF INSTRUCTION IN BUSINESS SKILL SUBJECTS (1-3)
- 460. CURRICULUMS IN BUSINESS EDUCATION (3)
- 461. IMPROVEMENT OF INSTRUCTION IN BASIC BUSINESS SUBJECTS (3)
- 462. TEACHING OF SHORTHAND AND TYPEWRITING (3)
- 463. TEACHING OF BOOKKEEPING (3)
- 466. TEACHING OF OFFICE PRACTICE (3)
- 467. TEACHING OF SHORTHAND (2-3)
- 468. TEACHING OF TYPEWRITING (2-3)
- 472. MEASUREMENT OF ACHIEVEMENT IN THE SECONDARY SCHOOL (2-3)
- 497. WORKSHOP IN SELECTED STUDIES IN SECONDARY EDUCATION (1-6)



## SECONDARY EDUCATION

510. INTERNSHIP IN SECONDARY SCHOOL TEACHING (3-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
511. INTERNSHIP IN BUSINESS EDUCATION SUPERVISION (3-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
525. MODERN TENDENCIES IN EDUCATIONAL METHOD (2-3) Study of science supporting dynamic instruction; principles of teaching as guides; analysis of modern procedures; understanding of learning; substance versus plans. Prerequisite: 12 credits of undergraduate work in education.
532. SUPERVISION OF STUDENT TEACHERS (3) A course in supervision for master teachers, department heads, and college teachers with supervisory responsibilities in teacher education. Prerequisite: teaching experience and 18 credits in education, including at least 5 in methods.
537. (Bot. 537, Zool. 537). WORKSHOP IN THE BIOLOGICAL SCIENCES (3) Projects designed for teachers of biology in the secondary schools.
550. PROBLEMS IN MODERN SECONDARY EDUCATION (1-4) Historical, psychological, social, and economic factors influencing secondary education; required as basic course of all graduate students in secondary education. Prerequisite: secondary school teaching.
551. SEMINAR IN CONTEMPORARY ISSUES IN THE SECONDARY SCHOOL CURRICULUM (2-3) Principles and philosophy of curriculum construction. Each student works out an individual problem in the secondary school curriculum. Prerequisites: 12 credits in education and psychology, and teaching experience.
552. SEMINAR IN CONTEMPORARY ISSUES IN LABORATORY STUDIES IN THE APPLICATION OF EDUCATIONAL METHOD (2-3) Analysis and application of outstanding studies in secondary education; integration of results of educational research with public school procedures. Prerequisites: 12 credits in education and psychology, and teaching experience.
553. SEMINAR IN CONTEMPORARY ISSUES IN THE ORGANIZATION AND ADMINISTRATION OF SECONDARY EDUCATION (2-3) Problems in the reorganization of secondary education, with particular reference to philosophy, organization, and teaching problems of the junior high school. Prerequisites: 12 credits in education and psychology, and teaching experience.
575. ADMINISTRATION AND SUPERVISION IN BUSINESS EDUCATION (3) Work of administrators, supervisors, and others responsible for improvement of instruction in business education; use of vocational testing; job analysis. Prerequisite: 6 credits in secondary education.
576. INTRODUCTION TO RESEARCH IN BUSINESS EDUCATION (3) Methods of research in business education; opportunity to compile annotated bibliographies on current problems; analysis and evaluation of significant research.
577. EVALUATION OF RESEARCH AND EMPIRICAL LITERATURE IN BUSINESS EDUCATION (3) Application of evaluation methods to current literature in business education; special attention to research studies. Prerequisite: Sec.Ed. 576.
578. SEMINAR IN BUSINESS EDUCATION (1-6) Intended for graduate students preparing theses or final documents, or for those working on special studies in business education. Prerequisite: Sec.Ed. 577.



585. CURRICULUM CONSTRUCTION (2-3) Functions of administrators, supervisors, teachers, pupils, and laymen in curriculum building to meet pupil and community needs.
594. SEMINAR IN SECONDARY EDUCATION (1-3) Conferences and discussions designed to meet the need for special study of particular fields in secondary education. Prerequisite: 12 credits of graduate work in education.
597. WORKSHOP IN CURRENT EDUCATIONAL PROBLEMS IN SECONDARY EDUCATION (1-6) For administrators, supervisors, experienced secondary teachers, guidance workers; administrative, supervisory, and instructional problems involved in an emerging educational program. Prerequisite: 12 credits of graduate work in education.
598. PROBLEMS, PROJECTS, AND AREA STUDIES IN SECONDARY EDUCATION (1-6) Independent work in the study of topics in secondary education or the development of new curriculums, materials, or procedures for teaching. Prerequisites: 12 credits of graduate work in education and approval of the department head.

## SOCIAL STUDIES

NEIL A. McNALL  
*Chairman of the Committee on Social Studies*  
 115 Sparks Building

*Degree Conferred: M.Ed.*

This program, designed to meet the needs of secondary school teachers, consists of at least 24 credits chosen from economics, history, human geography, political science, and sociology, and a minor of at least 6 credits in educational foundations. A candidate is expected to complete at least 3 credits in each of four fields and not more than 12 credits in one of them.

To undertake graduate work in this field, the student must have had solid preparation in the basic courses in history, political science, economics, and sociology; and he should have had some advanced undergraduate work in at least one of the fields named. He should be certified for teaching social studies, and ideally he should have had teaching experience in this field as well.

## SOCIOLOGY

WILLIAM G. MATHER  
*Head of the Department of Sociology and Anthropology*  
 239 Sparks Building

*Degrees Conferred: Ph.D., M.A.*

*Graduate Faculty:* Professors Bernard, Clark, Coutu, Mather, F. R. Matson, and Mook; Associate Professors Dupree and M. B. Matson; Assistant Professors Baker, Dansereau, and Theodorson.

Undergraduate preparation must include 12 credits in sociology and at least 7 in other social sciences, with a broad background in the arts and sciences preferred. Students of exceptional ability who are slightly deficient in undergraduate preparation may

## SOCIOLOGY

be accepted, on condition that they make up their deficiency in courses without degree credit.

Anthropology may be chosen as a minor field of study by students who are majoring in sociology as well as in other areas.

### SOCIOLOGY (SOC)

400. SOCIOLOGICAL PRINCIPLES (3)  
401. SOCIAL INSTITUTIONS (3)  
403. ADVANCED SOCIAL PSYCHOLOGY (3) *Mr. Coutu*  
405. SOCIAL ADJUSTMENT IN WORK LIFE (3)  
408. SOCIAL ECOLOGY (3) *Mr. Theodorson*  
413. METHODS AND TECHNIQUES OF SOCIAL RESEARCH (1-6) *Mr. Dansereau*  
417. ANALYTICAL SOCIAL THEORY (3)  
418. THE DEVELOPMENT OF SOCIAL THOUGHT (3)  
424. SOCIAL CHANGE (3)  
425. CONTEMPORARY SOCIOLOGICAL THEORY (3)  
426. INTRODUCTION TO PUBLIC WELFARE (3)  
427. SOCIAL CASE WORK (3)  
429. SOCIAL STRATIFICATION (3)  
431. COMMUNICATION AND MASS SOCIETY (3)  
450. COMMUNITY ORGANIZATION (3)  
455. OCCUPATIONS AND PROFESSIONS (3) *Mr. Dansereau*  
470. USE OF STATISTICS IN SOCIOLOGY (3) *Mr. Clark*  
499. FOREIGN STUDY IN SOCIOLOGY (2-6)
500. SEMINAR IN GROUP THEORY (1-3) The group as a unit of social structure and action.
503. RESEARCH SEMINAR IN SOCIAL PSYCHOLOGY (3-6) Design and conduct of research in areas of mutual interest in social psychology. *Mr. Coutu*
505. CURRENT SOCIAL THEORY (3) Current contributions to social theory; their relations to each other and to the larger theoretical structure. *Mr. Theodorson*
510. FIELD WORK IN SOCIOLOGY (1-6)
513. SEMINAR IN SOCIOLOGICAL RESEARCH PROBLEMS: A. RESEARCH TECHNIQUES; B. CURRENT RESEARCH (3-6) Prerequisite: 3 credits in statistics. *Mr. John*
515. SEMINAR IN COMMUNITY STUDIES (3) *Mrs. Bernard*
516. SEMINAR IN SOCIOLOGICAL THEORY (3-6)
523. POPULATION PROBLEMS (1-6)
525. SEMINAR IN SOCIOLOGY (1-6) Research problems in theoretical and applied sociology.
530. RESEARCH ON MARRIAGE AND THE FAMILY (3) Training in methods and techniques of research in family relations. Experimental, statistical, and comparative studies are carried out, individually or co-operatively. Prerequisite: 3 credits of previous work in this field. *Mrs. Bernard*
555. INDUSTRIAL SOCIOLOGY (3) Research methods and techniques in industrial sociology; current research, unexplored areas.
572. METHODS OF SAMPLING (3) Application of sampling techniques to sociological research. *Mr. Clark*

ANTHROPOLOGY (ANTHY)

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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 401. PHYSICAL ANTHROPOLOGY: HUMAN EVOLUTION (3)                                                                                                                                               | Mr. Baker |
| 402. HUMAN ECOLOGY (3)                                                                                                                                                                        | Mr. Baker |
| 442. ANTHROPOLOGY OF THE NEW WORLD (3)                                                                                                                                                        |           |
| 443. ANTHROPOLOGY OF THE OLD WORLD AND MIDDLE EAST (3)                                                                                                                                        | Mr. Mook  |
| 445. PRIMITIVE SOCIETY (3)                                                                                                                                                                    | Mr. Mook  |
|                                                                                                                                                                                               |           |
| 540. ANTHROPOLOGICAL THEORY (3) Theory used in culture-historical, sociological, and psychological interpretations.                                                                           | Mr. Mook  |
| 541. RESEARCH METHODS IN ANTHROPOLOGY (3) Principles, techniques, and examples of both field and library research in anthropology. Students will prepare research plans for class discussion. |           |
| 545. SEMINAR IN ANTHROPOLOGY (1-9) Critical analysis of research in selected areas of regional ethnography and ethnological theory. Prerequisites: Anthy. 45, 445.                            | Mr. Mook  |

ARCHAEOLOGY (ARCHY)

- |                                                |            |
|------------------------------------------------|------------|
| 400-401. ARCHAEOLOGY OF THE NEAR EAST (3 each) | Mr. Matson |
| 402-403. ARCHAEOLOGY OF THE NEW WORLD (3 each) | Mr. Matson |

SPEECH

ROBERT T. OLIVER, *Head of the Department*  
300 Sparks Building

*Degrees Conferred:* Ph.D., D.Ed., M.A., M.Ed.

*Graduate Faculty:* Professors McDonald, Oliver, Schug, and Zelko; Associate Professors Brubaker, Carter, Fife, Frick, Holtzman, Nelson, Siegenthaler, and White.

The student may specialize in speech arts (interpretation, drama, theatre); radio and television; rhetoric and public address (including discussion, communication, teaching of speech); speech science (voice, diction, phonetics, general semantics); or speech pathology and audiology.

The minimum undergraduate preparation required is 12 credits in speech, including a beginning public speaking course and speech science with group discussion and persuasion. Students who cannot meet this requirement in full may be admitted, but must make up their deficiencies without credit toward the graduate degree. If a specific course in speech research methods is not offered, Spch. 401 will be required as a part of the graduate program.

SPEECH (SPCH)

- |                                                                 |              |
|-----------------------------------------------------------------|--------------|
| 400. TEACHING OF SPEECH (3)                                     | Mr. Schug    |
| 401. PROBLEMS, METHODS, AND AREAS IN SPEECH (3)                 | Mr. Carter   |
| 402. INTRODUCTION TO GENERAL SEMANTICS (3)                      | Mr. Carter   |
| 410. ENGLISH PHONETICS AND PRONUNCIATION (3)                    | Mr. Brubaker |
| 412. SPEECH COMPOSITION (3)                                     |              |
| 415. EXPERIMENTAL AND APPLIED PHONETICS (3)                     | Mr. Brubaker |
| 425. ADVANCED PRINCIPLES OF RADIO SPEECH (3)                    | Mr. Nelson   |
| 431. ANATOMY AND PHYSIOLOGY OF THE EAR AND VOCAL MECHANISMS (3) | Mr. Brubaker |



## SPEECH

435. TELEVISION AND RADIO ORGANIZATION (3) *Mr. Nelson*  
437. ADVANCED PRINCIPLES OF TELEVISION SPEECH (3) *Mr. Nelson*  
445. CONTEMPORARY PUBLIC ADDRESS (3)  
450. DISCUSSION TECHNIQUES (3)
500. SEMINAR IN AMERICAN ORATORY (2-4) History of American oratory, with application of critical standards to the work of specific orators. Prerequisite: 6 credits in speech, including Spch. 200. *Mr. Oliver*
505. HISTORICAL DEVELOPMENT OF SPEECH THEORY (2-4) Survey of ancient, medieval, and modern theories of public address in relation to currently accepted speech theories. *Mr. White*
508. SEMINAR IN BRITISH ORATORY (2-4) History of British oratory; application of critical standards to the work of selected orators. *Miss Fife*
510. SEMINAR IN SPEECH PEDAGOGY (2-4) *Mr. Carter*
520. SEMINAR IN SPEECH SCIENCE (2-4) Seminar in physical and physiological bases of speech and voice; introduction to laboratory techniques used in speech research. Prerequisite: 9 credits in speech, speech education, or psychology. *Mr. Brubaker*
540. SEMINAR IN PROBLEMS OF TELEVISION AND RADIO (2-4) Study and research in television and radio as they pertain to programming, production, relation to society, and speech. *Mr. Nelson*
550. SEMINAR IN ORAL PERSUASION (2-4) Theory and devices of persuasion; analysis of persuasive discourse. Prerequisite: 6 credits in speech including Spch. 200. *Mr. Holtzman*
552. ORAL COMMUNICATION IN INDUSTRY, BUSINESS, AND GOVERNMENT (2-4) Needs, practices, and methods in American industry, business, and government; methods of training adults in oral communication skills. *Mr. Zelko*
555. SPEECH COMMUNICATION: PROBLEMS AND PRINCIPLES (2-4) Prevalent theories of speech influence. *Mr. Oliver*
560. PUBLIC ADDRESS (2-4) Discussion and criticism of speech outline, manuscript, content, composition, and delivery. Prerequisite: 6 credits in speech including Spch. 200. *Mr. Schug*
575. RESEARCH PROBLEMS IN SPEECH (1-12) Advanced research on an individual basis in oratorical criticism, discussion techniques, persuasion, pedagogy, phonetics, speech science, and speech pathology. Prerequisite: 12 credits in speech or speech education.

## STATISTICS

JAMES B. BARTOO, *Chairman of the Committee on Statistics*  
219 Sparks Building

No advanced degree is offered in this field, but a candidate with a major in another field may choose a minor in statistics upon approval by his major department.

This minor is intended to facilitate development of a coherent program of study in this vital branch of the scientific method. The candidate will be expected to become conversant with the broad field of statistics and to become reasonably proficient in the

statistical methods particularly useful in the subject-matter areas of his major field. The member of the candidate's committee representing the minor in statistics will have responsibility for determining course work acceptable in satisfying requirements for the minor.

The minimum requirements for a minor for a master's degree are 3 credits in mathematical statistics and 6 in applied statistics. For a doctor's degree a minimum of 15 credits in statistics is required for a minor, of which at least 6 must be mathematical statistics and at least 6 must be applied statistics.

Courses in mathematical statistics are: Math. 409, 410, 542, and 543.

Courses in applied statistics are: Ag. 400; A.B.Ch. 515; Ag.Ec. 505; Ag.Ed. 521v; Agro. 512, 545; B.S. 500, 501; Econ. 510; Ed.Ser. 490, 590; For. 450; I.E. 423; Meteo. 450; Min. 513, 514, 526; Psy. 415, 515, 527; and Soc. 470, 572.

## THEATRE ARTS

WALTER H. WALTERS, *Head of the Department*  
201 Schwab Auditorium

*Degree Conferred:* M.A.

*Graduate Faculty:* Professors Neusbaum, Smith, and Walters; Associate Professors Reifsneider and Yeaton.

Under certain circumstances the Ph.D. degree is offered by the Department of English with specialization in drama and minor work in theatre arts.

A course in basic acting, one in directing, and one in theatre crafts, or their equivalents, are required for admission. In addition, the student must have had 12 credits divided between speech and the arts (including music, sculpture, painting, architecture, and other courses in which art is practiced); or a minimum of 9 credits in one of these; or a minimum of 9 credits in English and literature, including at least 6 in dramatic literature, or 3 in dramatic literature and 3 in advanced creative writing.

### THEATRE ARTS (THEA)

- 404. STYLES OF ACTING (3-6)
- 412. ADVANCED SCENE DESIGN (3)
- 413. STAGE LIGHTING (3)
- 415. THEATRE ORGANIZATION AND MANAGEMENT (3)
- 421. ADVANCED PLAYWRITING (3)
- 431. HISTORY OF THE THEATRE (3)
- 433. DANCE FOR THE THEATRE (3)
- 442. CREATIVE DRAMATICS WITH CHILDREN (3)
- 443. MARIONETTES AND PUPPETRY (3)
- 451. DIRECTING (3)
- 452. CENTRAL STAGING (3)
- 470. THEATRE PRODUCTION (3-6)
- 481. TELEVISION DRAMA (3)
  
- 501. PROBLEMS OF DIRECTING (3-6) Seminar in problems of production with particular stress on direction. Students will direct plays under staff supervision.
- 502. SEMINAR IN THE TECHNICAL PROBLEMS OF DRAMATIC PRODUCTION (3-6) Pre-requisite: Thea. 11.

## THEATRE ARTS

504. SEMINAR IN STYLES OF ACTING (3-6) Practical work required of each student.
506. EVALUATION AND APPRECIATION OF MODERN DRAMATIC ENTERTAINMENT (3)  
Prerequisites: Thea. 1, 61.
507. SEMINAR IN FUNDAMENTAL THEORIES OF THEATRE AND DRAMA (3-6)
521. PLAYWRITING (3-6) Prerequisites: Thea. 21, 421.

## VOCATIONAL INDUSTRIAL EDUCATION

(See page 116, Industrial Arts Education and Vocational Industrial Education.)

## WILDLIFE MANAGEMENT

*Consult* BERTIL G. ANDERSON  
212 Frear Laboratory

The M.S. degree is offered in the field of wildlife management. Candidates select courses for this major from a number of related fields.

## ZOOLOGY

BERTIL G. ANDERSON  
*Head of the Department of Zoology and Entomology*  
212 Frear Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Anderson, Davis, and Frings; Associate Professors Anthony, Cooper, and Wood; Assistant Professors Bellis, Boyle, and Smyth.

Students may specialize in animal behavior, bioacoustics, ecology, endocrinology, fishery biology, genetics, histology, ichthyology, invertebrate zoology, invertebrate physiology, or wildlife management.

In order to undertake graduate work in zoology, students are required to have had 24 credits in zoology and related biological sciences; and they should have had chemistry through organic chemistry. Courses in physics and mathematics are also advantageous. A limited deficiency can be made up without degree credit while pursuing graduate work.

### ZOOLOGY (ZOO L)

- |                                                |              |
|------------------------------------------------|--------------|
| 401. (P.H. 401, Psy. 401). ANIMAL BEHAVIOR (3) | Mr. Hale     |
| 403. (Ent. 403). SYSTEMATICS (3)               | Mr. Boyle    |
| 405. (Bot. 405). GENERAL CYTOLOGY (3)          | Mr. Grun     |
| 408. MAMMALOGY (4)                             | Mr. Davis    |
| 410. GENERAL LIMNOLOGY (3)                     | Mr. Cooper   |
| 415. THE LITERATURE OF ZOOLOGY (1)             | Mr. Anderson |
| 416. THE METHODS OF RESEARCH IN ZOOLOGY (2)    | Mr. Anderson |



417. INVERTEBRATE ZOOLOGY (3) *Mr. Frings*  
 419. GENERAL ANIMAL ECOLOGY (3) *Mr. Bellis*  
 420. GAME BIRDS (3) *Mr. Wood*  
 421. COMPARATIVE ANATOMY OF VERTEBRATES (4)  
 422. (Bot. 422). ADVANCED GENETICS (3) *Mr. Wright*  
 432. HUMAN PARASITOLOGY (3)  
 433. (Bot. 433). GENETICS, EUGENICS, AND EVOLUTION FOR TEACHERS (3)  
*Messrs. Wright and Grun*  
 436. PROTOZOOLOGY (3)  
 437. HISTOLOGY (4) *Mr. Anthony*  
 440. EMBRYOLOGY (4)  
 441. ESSENTIALS OF HUMAN PHYSIOLOGY FOR TEACHERS (3)  
 444. ZOOLOGICAL PROBLEMS (1-6)  
 448. ORNITHOLOGY (3) *Mr. Wood*  
 450. ICHTHYOLOGY (3) *Mr. Cooper*  
 461. ANIMAL PARASITOLOGY (3)  
 505. (Bot. 505). CYTOLOGY AND CYTOGENETICS (3) Chromosome mechanism of heredity; relationship between plant and animal evolution and breeding and changes in chromosomes; cytological and cytochemical techniques. Prerequisite: Zool. (Bot.) 405 or 422. Fall semester, even years. *Mr. Grun*  
 508. ADVANCED PARASITOLOGY (3) Advanced work on the structure, life cycle, and control of parasites.  
 509. TECHNIQUES IN WILDLIFE MANAGEMENT (3) Preparing study mounts, census making, management area mapping, methods of collecting data, and determining food habits from stomach contents. Prerequisite: Zool. 546. Spring semester.  
 512. SEMINAR (1) Review of current zoological literature. Required of graduate students majoring in zoology and entomology. Prerequisite: 12 credits in zoology or entomology.  
 520. SPECIAL TOPICS (1-6)  
 524. (Bot. 524). SEMINAR IN GENETICS (1 per semester) *Mr. Wright*  
 525. HISTORY OF BIOLOGY (3) Historical development of biological knowledge and theories. *Mr. Frings*  
 528. (Bot. 528). POPULATION GENETICS (3) Factors affecting gene frequency, genotype frequency, genotype-environmental interaction, and genetic relationship in natural and artificial populations. Fall semester, odd years.  
 533. (Bot. 533). PROBLEMS IN GENETICS (2-6) Problems to suit needs of individual students; conferences and laboratory work. Prerequisite: Zool. (Bot.) 422. *Messrs. Wright and Grun*  
 537. (Bot. 537, Sec.Ed. 537). WORKSHOP IN THE BIOLOGICAL SCIENCES (3) Projects designed for teachers of biology in the secondary schools. Summer term.  
 541. COMPARATIVE PHYSIOLOGY (3) Dynamics of vital processes as shown in members of the animal kingdom. Prerequisites: Zool. 26; A.B.Ch. 1; A.B.Ch. 425 or Zool. 437. Spring semester. *Mr. Smyth*  
 546. THE THEORY OF GAME MANAGEMENT (4) Fundamental principles underlying management of wild game birds and mammals; co-ordination of such management with various land uses; planning preserves and other land areas. Prerequisites: Zool. 408, 420. Fall semester. *Mr. Davis*

## ZOOLOGY

551. FISHERIES MANAGEMENT (3) Basic principles underlying management of inland waters for fish production. Prerequisite: Zool. 450. Spring semester, odd years.  
*Mr. Cooper*
581. ADVANCED INVERTEBRATE ZOOLOGY (3) Morphology, physiology, taxonomy, and life histories of invertebrate animals. Fall semester, even years. *Mr. Frings*
582. (P.H. 582, Psy. 582). RESEARCH IN ANIMAL BEHAVIOR (2-6 per semester) Research in special areas of animal behavior involving field and laboratory work. Prerequisite: Zool. (P.H., Psy.) 401; or Psy. 403.  
*Messrs. Hale, Schein, Davis, and Frings*
583. GENERAL ENDOCRINOLOGY (2) Anatomy and physiology of the organs of internal secretion; role of hormones in metabolism and development. Spring semester, odd years. *Mr. Anthony*
587. BIOLOGY OF SEX (2) Hereditary and embryological aspects, problems in gonadal differentiation, cyclic reproductive phenomena, actions of the hormones. Spring semester, even years. *Mr. Anthony*

## Part II

### Other Elective Graduate Courses

The following courses are in fields in which neither major nor minor work is offered at this institution. The courses, however, carry graduate credit and, with the approval of the major department, may be applied toward the requirements for a degree either as elective courses or as a part of a general studies program. The usual restrictions upon the use of 400 series courses in degree programs apply to these courses.

#### AGRICULTURE, GENERAL (AG)

400. INTRODUCTORY BIOMETRY (3)

#### ASTRONOMY (ASTRO)

430. GENERAL ASTRONOMY FOR TEACHERS (3)

470. SOLAR PHYSICS (3)

490-491. INTRODUCTION TO ASTROPHYSICS (3 each)

#### BROADCASTING (BRCST)

482. CREATIVE BROADCASTING (3)

#### COMMERCIAL CONSUMER SERVICES (C C S)

403. LECTURE-DEMONSTRATION TECHNIQUES (3)

*Miss Allgood*

450. PROBLEMS IN HOUSEHOLD EQUIPMENT (1-6)

*Miss Allgood*

#### ENGINEERING (ENGR)

422. ORDNANCE ENGINEERING: TORPEDO ENGINEERING (3)

430. INTRODUCTION TO DIGITAL COMPUTER PROGRAMMING (1)

431. DIGITAL COMPUTER PROGRAMMING (3)

450. PATENT FUNDAMENTALS (3)

500. SPECIAL TOPICS IN ENGINEERING (1-3)

531. ADVANCED DIGITAL COMPUTER PROGRAMMING (3) Programming for commercial computers; programming techniques; numerical methods for computers; solution of problems on the Penn State Digital Computer. Prerequisites: Math. 405, Engr. 431.

#### GREEK (GREEK)

421. GREEK TRAGEDY (3)

422. GREEK COMEDY (3)

500. GREEK COMPOSITION (2) Translation of extended narrative passages into Attic Greek; thorough review of forms and syntax; attention to rhetorical elements of the language.

#### HEALTH EDUCATION (HL ED)

403. FIRST AID, ATHLETIC CONDITIONING AND TRAINING (3)



## HEALTH EDUCATION

406. RECENT DEVELOPMENTS IN SCHOOL HEALTH EDUCATION (3)  
411. PRINCIPLES AND METHODS OF TEACHING SAFETY EDUCATION (3)  
456. ADVANCED TECHNIQUES IN RURAL SCHOOL HEALTH (3)  
  
501. HEALTH IMPLICATIONS IN THE GROWTH AND DEVELOPMENT OF SCHOOL CHILDREN (3) Child growth and development emphasis for teachers; medical inspection and examination; preschool program; early habit formations; behavior problems; co-operation of parents, teachers, and children. Prerequisite: Hl.Ed. 215.  
505. ADVANCED TECHNIQUES IN HEALTH EDUCATION (3) Prerequisites: Hl.Ed. 215, Psy. 437.  
572. TESTS AND MEASUREMENTS IN HEALTH EDUCATION (3) Critical study, evaluation, and demonstration of tests and measures of health education; statistical computations of data. Prerequisites: Ph.Ed. 490, Hl.Ed. 215.

## HOME-COMMUNITY RELATIONSHIPS (H C R)

499. INTERCULTURAL STUDIES IN HOME ECONOMICS (2-6)  
  
502, 502v. HOME ECONOMICS AND AMERICAN SOCIETY (3) Family life education in relation to a democratic culture; emphasis upon the interrelatedness of socioeconomic problems and the American family.  
503. GRADUATE SEMINAR IN HOME ECONOMICS (1) *Miss G. M. Henderson*

## INTERNATIONAL UNDERSTANDING (INT U)

400. WORLD AFFAIRS AND INTERNATIONAL UNDERSTANDING (3-6)

## LATIN (LATIN)

428. LUCRETIVS (3) *Mr. Krauss*  
429. QUINTILIAN (3) *Mr. Krauss*  
431. JUVENAL (3) *Mr. Krauss*  
436. FUNCTIONAL PROBLEMS IN LATIN (3)  
  
500. LATIN LITERATURE (3) Lectures and collateral readings on the major forms of Latin literature; readings in the original Latin to supplement the lectures. *Mr. Krauss*  
501. ROMAN RELIGION AND PHILOSOPHY (3) Development of religious concepts at Rome from primitive Italic origins to the advanced forms that culminated in Roman Stoicism. *Mr. Krauss*  
502. LATIN EPIGRAPHY (3) Lectures and readings on Roman inscriptions; illustrative exercises. *Mr. Krauss*  
503. LATIN PALEOGRAPHY (3) The Latin alphabet, writing materials, Roman book and cursive hands; illustrative exercises. *Mr. Krauss*  
504. ROMAN TOPOGRAPHY (3) Physical development of the city of Rome, its walls, aqueducts, bridges, streets, forums, public buildings, temples, etc.; building materials and methods of construction. *Mr. Krauss*  
510. LATIN SEMINAR (3) *Mr. Krauss*  
518. LATIN RESEARCH (1-3) Prosecution of an assigned problem under the guidance of a member of the department.

## LIBERAL ARTS (L A)

- 500-501. FUNDAMENTALS OF LINGUISTICS (3 each) Interrelated problems of language discussed from four points of view: modern structural linguistics, historical linguistics, social psychology, and philosophy.

## LIBRARY SCIENCE (L SC)

403. INTERMEDIATE DICTIONARY CATALOGING AND SUBJECT HEADINGS (3)  
 405. INTERMEDIATE REFERENCE WORK AND BIBLIOGRAPHY (3)  
 407. SPECIAL PROBLEMS IN SCHOOL LIBRARY SERVICE (6)

## MINERAL SCIENCES (MN SC)

411. INSTRUMENT TECHNIQUES APPLIED TO MINERAL SCIENCE PROBLEMS (1-3)  
     Unit A. *X-Ray Diffraction*  
     Unit B. *Electron Microscopy*  
     Unit C. *Spectroscopy*
510. X-RAY AND ELECTRON DIFFRACTION ANALYSIS AS APPLIED TO MINERALS AND METALS (2) Prerequisite: Phys. 285. *Mr. Brindley*
520. ELECTRON MICROSCOPY IN MINERAL SCIENCE RESEARCH (1-4) Prerequisite: Mn.Sc. 411, Unit B. *Messrs. Bates and Comer*
530. SPECTROSCOPY IN MINERAL SCIENCE RESEARCH (1-4) Prerequisite: Mn.Sc. 411, Unit C. *Mr. Lovell*
540. SOLID STATE STRUCTURES AND REACTIONS IN MINERAL SYSTEMS (2-4) Crystal chemical approach to solid state reactions, sintering, melting, hardness, thermal expansion, and behavior of matter under high pressure. *Mr. Weyl*

## NATURE EDUCATION (NA ED)

401. TRAINING IN NATURE FOR CAMP COUNSELORS (3)

## RELIGIOUS STUDIES (RL ST)

401. RELIGIOUS PHILOSOPHY OF THE GREAT REFORMERS (3)  
 402. CONTEMPORARY RELIGIOUS THOUGHT (3)  
 410. BIBLICAL STUDIES: OLD TESTAMENT (3)  
 420. BIBLICAL STUDIES: NEW TESTAMENT (3)  
 430. RELIGION AND MORALITY (3)

## RUSSIAN (RUS)

401. STUDIES IN RUSSIAN LITERATURE (3-6)  
 426. DOSTOEVSKI (3)  
 427. TOLSTOY (3)

\*1G. TECHNICAL RUSSIAN FOR GRADUATE STUDENTS (3) Prepares student to translate technical and scientific texts. No previous knowledge of Russian is required.

## VETERINARY SCIENCE (V SC)

400. VETERINARY ANATOMY AND PHYSIOLOGY (3)  
 401. INFECTIOUS DISEASES OF DOMESTIC ANIMALS (2)
515. (Bact. 515). VIROLOGY (2-4) Rickettsial and viral agents parasitizing man, animals, and microorganisms. Prerequisite: Bact. 410.

\*No graduate credit is given for this course.





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U.Ed. 0-431

# SUPPLEMENT TO THE PENNSYLVANIA STATE UNIVERSITY BULLETIN

VOLUME LV

February 1961

NUMBER 1

Effective with the summer of 1961, The Pennsylvania State University is changing its basic calendar from two semesters plus a summer session to four terms. Each term will be of 10 weeks duration, and a full-time graduate student will be permitted to register for a maximum of 10 credits per term. Accordingly, the credit system will remain unchanged, a credit continuing to be a "semester credit" rather than the "quarter credit" associated with the traditional quarter system.

As a result of recent official action associated with the calendar change, the following items appearing in the 1961-1962 issue of *Graduate Degree Programs* have undergone the changes listed below:

## \*1. GRADUATE CALENDAR (See page 4)

### †SUMMER TERM 1961

#### JUNE 1961

- 13-14 Tuesday and Wednesday—Summer Term Registration
- 13-14 Tuesday and Wednesday—Oral Examinations in Foreign Languages for Advanced Degree Candidates
- 15 Thursday—Summer Term Classes Begin 8 a.m.
- 15 Thursday—Last Date for Registering with Foreign Language Departments for Written Language Examinations

#### JULY

- 3 Monday—Written Foreign Language Examinations for Advanced Degree Candidates
- 4 Tuesday—Independence Day Recess
- 12 Wednesday—Last Date for Paying Thesis Fees and for Informing Recorder of Intention To Graduate in August
- 18 Tuesday—Graduate Faculty Meeting
- 29 Saturday—Last Date for an August Graduate To Deliver Doctoral Thesis to Committee

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\*This calendar was approved February 18, 1961. It is subject to change without notice.

†A *Summer Term Timetable* may be obtained by writing to the Scheduling Office, Room 4, Willard Building.



## AUGUST

- 5 Saturday—Last Date for Final Oral Doctoral Examination for August Graduates
- 5 Saturday—Last Date for an August Graduate to Deliver Master's Thesis to Adviser
- 5 Saturday—Last Date for an August Graduate to Rent Cap, Gown, and Hood Locally
- 12 Saturday—Theses Due in Graduate School Office 12 Noon
- 12 Saturday—Last Date for Submitting a Petition to Graduate in Absentia in August
- 15 Tuesday—Graduate Faculty Meeting
- 24 Thursday—Summer Term Classes End 9:55 p.m.
- 26 Saturday—Commencement

## *FALL TERM 1961*

## SEPTEMBER 1961

- 20-23 Wednesday to Saturday Noon—Fall Term Registration
- 20-23 Wednesday to Saturday Noon—Oral Examinations in Foreign Languages for Advanced Degree Candidates
- 25 Monday—Fall Term Classes Begin 8 a.m.
- 25 Monday—Last Date for Registering with Foreign Language Departments for Written Language Examinations

## OCTOBER

- 9 Monday—Written Foreign Language Examinations for Advanced Degree Candidates
- 17 Tuesday—Graduate Faculty Meeting

## NOVEMBER

- 21 Tuesday—Graduate Faculty Meeting
- 23 Thursday—Thanksgiving Day Recess

- ‡ 24 Friday—Last Date for Paying Thesis Fees and Informing Recorder of Intention To Graduate in June if Certification of Completion of Program Is To Be Issued in January
- ‡ 24 Friday—Last Date To Deliver Doctoral Theses to Committee for Candidates Seeking Certification of Completion in January
- ‡ 30 Thursday—Last Date To Deliver Master's Theses to Adviser for Candidates Seeking Certification of Completion in January
- ‡ 30 Thursday—Last Date for Final Oral Doctoral Examination for Candidates Seeking Certification of Completion in January

## DECEMBER

- ‡ 7 Thursday—Theses Due in Graduate School Office for Candidates Seeking Certification of Completion in January
- 7 Thursday—Fall Term Classes End 9:55 p.m.

## *WINTER TERM 1962*

### JANUARY 1962

- 3-4 Wednesday and Thursday—Winter Term Registration
- 5 Friday—Winter Term Classes Begin 8 a.m.

## MARCH

- 17 Saturday—Winter Term Classes End 12:25 p.m.

## *SPRING TERM 1962*

### MARCH 1962

- 26-27 Monday and Tuesday—Spring Term Registration
- 28 Wednesday—Spring Term Classes Begin 8 a.m.

## JUNE

- 8 Friday—Spring Term Classes End 9:55 p.m.
- 9 Saturday—Commencement

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‡Degrees will not be conferred at the end of the Fall Term, but candidates for advanced degrees who meet the above deadlines will be certified by the Dean of the Graduate School as having met all requirements for their degrees—the formal conferring of the degree to be done at Commencement in June 1962.

2. LOADS, ACADEMIC AND EMPLOYMENT (See pages 27-28)

A graduate student who has no employment may take a maximum of 10 credits in a term and will be expected to take at least 8 credits. A student who is employed 10, 20, or 30 hours per week will be limited to 7-9, 5-7, and 4-5 credits respectively. A student who is employed full time may schedule a maximum of 4 credits.

3. STATUS UNDER SELECTIVE SERVICE (See page 28)

A student who schedules at least 8 credits or who holds a quarter-time or half-time graduate assistantship will be certified as a full-time student.

4. GRADUATE ASSISTANTSHIPS (See pages 31-32)

A quarter-time graduate assistant may schedule 7-9 credits, a half-time assistant 5-7 credits, and a three-quarter-time assistant 4-5 credits per term.

The scale of stipends is unchanged. Hence the stipend for a term is one third of the published stipend for the academic year.

5. COUNSELORSHIPS FOR MEN (See page 32)

A counselor may not hold a fellowship, a graduate assistantship, or a graduate grant-in-aid during the term of his appointment as a counselor; he may carry only 8 credits per term.

6. GRADUATE GRANTS-IN-AID (See page 36)

A recipient is expected to carry a full program of graduate work but may accept employment with the University or another employer not to exceed 10 hours per week, provided he reduces his academic load to 8 or 9 credits.

7. HEALTH CENTER (See page 37)

The services of the Ritenour Health Center are available to graduate students registered for 8 or more credits and to all graduate assistants, fellows, and scholars. Students are entitled to five days of free treatment each term. For each day of confinement in excess of five days a charge of \$10 will be made.

8. RESIDENCE REQUIREMENTS (See page 42)

A minimum of nine terms of full-time graduate study and research, or the equivalent in credits, is required for a doctor's degree. At least 30 credits must be earned in residence at the University Park Campus.

For a period of three terms, two of which must be consecutive, the Ph.D. candidate must limit his work load to half-time at most, the balance of his time being devoted to graduate study.

9. LANGUAGE EXAMINATIONS (See page 44)

The language examinations for advanced degree candidates will be held four times each year, once during each term.

U.Ed. 1-416











1962-1963

THE PENNSYLVANIA STATE  
UNIVERSITY BULLETIN

GRADUATE DEGREE PROGRAMS

GENERAL CATALOG ISSUE • FEBRUARY 1962



OFFICE OF THE GRADUATE SCHOOL  
101 WILLARD BUILDING

NOTICE: The University operates throughout the year on a four-term basis. The fall, winter, spring, and summer terms consist of 10 weeks each.

LAND-GRANT CENTENNIAL: During 1962 The Pennsylvania State University joins the other land-grant colleges and universities of the United States in commemorating the Centennial of the Land-Grant Act. This act, signed by President Abraham Lincoln in 1862, laid the foundation for our great system of state-supported land-grant institutions, established "to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life."

LOCATION: The post office address of The Pennsylvania State University is University Park, Pennsylvania, but the town in which the University is located is State College.

THE PENNSYLVANIA STATE UNIVERSITY BULLETIN  
VOLUME LVI                      February 1962                      NUMBER 1

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UNIVERSITY PARK, PENNSYLVANIA

**1962-1963**  
**THE PENNSYLVANIA STATE**  
**UNIVERSITY**

**GRADUATE DEGREE PROGRAMS**

**GENERAL CATALOG ISSUE • FEBRUARY 1962**



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# \* GRADUATE CALENDAR

## WINTER TERM 1962

### JANUARY 1962

- 3-4 Wednesday and Thursday—Winter Term Registration
- 3-4 Wednesday and Thursday—Oral Examinations in Foreign Languages for Advanced Degree Candidates
- 5 Friday—Winter Term Classes Begin 8 a.m.
- 5 Friday—Last Date for Registering with Foreign Language Departments for Written Language Examinations
- 15 Monday—Last Date for Adding Courses to Approved Schedules
- 16 Tuesday—Graduate Faculty Meeting
- 22 Monday—Last Date for Paying Thesis Fees and for Informing Recorder of Intention to Graduate in March
- 29 Monday—Written Foreign Language Examinations for Advanced Degree Candidates

### FEBRUARY

- 17 Saturday—Last Date for a March Graduate to Deliver Doctoral Thesis to Committee
- 20 Tuesday—Graduate Faculty Meeting
- 24 Saturday—Last Date for Final Oral Doctoral Examination for March Graduates
- 24 Saturday—Last Date for a March Graduate to Deliver Master's Thesis to Adviser
- 24 Saturday—Last Date for a March Graduate to Rent Cap, Gown, and Hood Locally

### MARCH

- 3 Saturday—Theses Due in Graduate School Office 12 Noon
- 3 Saturday—Last Date for Submitting a Petition to Graduate in Absentia in March
- 17 Saturday—Winter Term Classes End 12:25 p.m.
- 18 Sunday—Commencement

## SPRING TERM 1962

### MARCH 1962

- 26-27 Monday and Tuesday—Spring Term Registration
- 26-27 Monday and Tuesday—Oral Examination in Foreign Languages for Advanced Degree Candidates
- 28 Wednesday—Spring Term Classes Begin 8 a.m.
- 28 Wednesday—Last Date for Registering with Foreign Language Departments for Written Language Examinations

### APRIL

- 6 Friday—Last Date for Adding Courses to Approved Schedules
- 16 Monday—Last Date for Paying Thesis Fees and for Informing Recorder of Intention to Graduate in June

\*This calendar was approved August 10, 1961. It is subject to change without notice.

- 17 Tuesday—Graduate Faculty Meeting
- 23 Monday—Written Foreign Language Examinations for Advanced Degree Candidates

## MAY

- 12 Saturday—Last Date for a June Graduate to Deliver Doctoral Thesis to Committee
- 15 Tuesday—Graduate Faculty Meeting
- 19 Saturday—Last Date for Final Oral Doctoral Examination for June Graduates
- 19 Saturday—Last Date for a June Graduate to Deliver Master's Thesis to Adviser
- 19 Saturday—Last Date for a June Graduate to Rent Cap, Gown, and Hood Locally
- 26 Saturday—Theses Due in Graduate School Office 12 Noon
- 26 Saturday—Last Date for Submitting a Petition to Graduate in Absentia in June

## JUNE

- 8 Friday—Spring Term Classes End 9:55 p.m.
- 9 Saturday—Commencement

## SUMMER TERM 1962

### JUNE 1962

- 19 Tuesday—Summer Term Registration
- 19 Tuesday—Oral Examination in Foreign Languages for Advanced Degree Candidates
- 20 Wednesday—Summer Term Classes Begin 8 a.m.
- 20 Wednesday—Last Date for Registering with Foreign Language Departments for Written Language Examinations
- 29 Friday—Last Date for Adding Courses to Approved Schedules

## JULY

- \*4 Wednesday—Independence Day Recess
- 9 Monday—Last Date for Paying Thesis Fees and for Informing Recorder of Intention to Graduate in September
- 16 Monday—Written Foreign Language Examinations for Advanced Degree Candidates
- 17 Tuesday—Graduate Faculty Meeting

## AUGUST

- 4 Saturday—Last Date for a September Graduate to Deliver Doctoral Thesis to Committee
- 11 Saturday—Last Date for Final Oral Doctoral Examination for September Graduates

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\*Classes which would have met on Wednesday, July 4, will meet according to schedule on Wednesday, August 29.

- 11 Saturday—Last Date for a September Graduate to Deliver Master's Thesis to Adviser
- 11 Saturday—Last Date for a September Graduate to Rent Cap, Gown, and Hood Locally
- 18 Saturday—Theses Due in Graduate School Office 12 Noon
- 18 Saturday—Last Date for Submitting a Petition to Graduate in Absentia in September
- 21 Tuesday—Graduate Faculty Meeting
- 29 Wednesday—Summer Term Classes End 9:55 p.m.

## SEPTEMBER

- 1 Saturday—Commencement

## *FALL TERM 1962*

## SEPTEMBER 1962

- 19-22 Wednesday to Saturday Noon—Fall Term Registration
- 19-22 Wednesday to Saturday—Oral Examination in Foreign Languages for Advanced Degree Candidates
- 24 Monday—Fall Term Classes Begin 8 a.m.
- 24 Monday—Last Date for Registering with Foreign Language Departments for Written Language Examinations

## OCTOBER

- 3 Wednesday—Last Date for Adding Courses to Approved Schedules
- 15 Monday—Last Date for Paying Thesis Fees and for Informing Recorder of Intention to Graduate in December
- 16 Tuesday—Graduate Faculty Meeting
- 22 Monday—Written Foreign Language Examinations for Advanced Degree Candidates

## NOVEMBER

- 10 Saturday—Last Date for a December Graduate to Deliver Doctoral Thesis to Committee
- 17 Saturday—Last Date for Final Oral Doctoral Examination for December Graduates
- 17 Saturday—Last Date for a December Graduate to Deliver Master's Thesis to Adviser
- 17 Saturday—Last Date for a December Graduate to Rent Cap, Gown, and Hood Locally
- 20 Tuesday—Graduate Faculty Meeting
- †22 Thursday—Thanksgiving Day Recess
- 24 Saturday—Theses Due in Graduate School Office 12 Noon
- 24 Saturday—Last Date for Submitting a Petition to Graduate in Absentia in December

## DECEMBER

- 3 Monday—Fall Term Classes End 9:55 p.m.
- 8 Saturday—Commencement

†Classes which would have met on Thursday, November 22, will meet according to schedule on Monday, December 3.



## WINTER TERM 1963

### JANUARY 1963

- 3-5 Thursday to Saturday Noon—Winter Term Registration
- 3-5 Thursday to Saturday—Oral Examination in Foreign Languages for Advanced Degree Candidates
- 7 Monday—Winter Term Classes Begin 8 a.m.
- 7 Monday—Last Date for Registering with Foreign Language Departments for Written Language Examinations
- 15 Tuesday—Graduate Faculty Meeting
- 16 Wednesday—Last Date for Adding Courses to Approved Schedules
- 28 Monday—Last Date for Paying Thesis Fees and for Informing Recorder of Intention to Graduate in March

### FEBRUARY

- 4 Monday—Written Foreign Language Examinations for Advanced Degree Candidates
- 16 Saturday—Last Date for a March Graduate to Deliver Doctoral Thesis to Committee
- 19 Tuesday—Graduate Faculty Meeting
- 23 Saturday—Last Date for Final Oral Doctoral Examination for March Graduates
- 23 Saturday—Last Date for a March Graduate to Deliver Master's Thesis to Adviser
- 23 Saturday—Last Date for a March Graduate to Rent Cap, Gown, and Hood Locally

### MARCH

- 2 Saturday—Theses Due in Graduate School Office 12 Noon
- 2 Saturday—Last Date for Submitting a Petition to Graduate in Absentia in March
- 16 Saturday—Winter Term Classes End 12:25 p.m.
- 17 Sunday—Commencement

## SPRING TERM 1963

### MARCH 1963

- 25-27 Monday to Wednesday—Spring Term Registration
- 25-27 Monday to Wednesday—Oral Examination in Foreign Languages for Advanced Degree Candidates
- 28 Thursday—Spring Term Classes Begin 8 a.m.
- 28 Thursday—Last Date for Registering with Foreign Language Departments for Written Language Examinations

### APRIL

- 6 Saturday—Last Date for Adding Courses to Approved Schedules
- 15 Monday—Last Date for Paying Thesis Fees and for Informing Recorder of Intention to Graduate in June
- 16 Tuesday—Graduate Faculty Meeting
- 22 Monday—Written Foreign Language Examinations for Advanced Degree Candidates

## MAY

- 11 Saturday—Last Date for a June Graduate to Deliver Doctoral Thesis to Committee
- 18 Saturday—Last Date for Final Oral Doctoral Examination for June Graduates
- 18 Saturday—Last Date for a June Graduate to Deliver Master's Thesis to Adviser
- 18 Saturday—Last Date for a June Graduate to Rent Cap, Gown, and Hood Locally
- 21 Tuesday—Graduate Faculty Meeting
- 25 Saturday—Theses Due in Graduate School Office 12 Noon
- 25 Saturday—Last Date for Submitting a Petition to Graduate in Absentia in June

## JUNE

- 5 Wednesday—Spring Term Classes End 9:55 p.m.
- 8 Saturday—Commencement

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HARRY A. ATWATER, Ph.D. (Harvard)	<i>Assoc. Prof. of Electrical Engineering</i>
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LEONARD G. AUSTIN, Ph.D. (Penn State)	<i>Assoc. Professor of Fuel Technology</i>



## GRADUATE FACULTY

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RAYMOND G. D. AYOUB, Ph.D. (Illinois)	Professor of Mathematics
RUTH W. AYRES, Ph.D. (Brookings)	Professor of Clothing and Textiles
FRANCIS A. BABIONE, Ph.D. (Ohio State)	Associate Professor of Marketing
PAUL T. BAKER, Ph.D. (Harvard)	Associate Professor of Anthropology
HUBERT L. BARNES, Ph.D. (Columbia)	Assistant Professor of Geochemistry
ROBERT M. BARNOFF, M.S. (Penn State), P.E.	Asst. Prof. of Civil Engineering
WILLIAM L. BARR, Ph.D. (Cornell)	Professor of Farm Management
GEORGE P. BARRON, JR., Ph.D. (Penn State)	Professor of Animal Nutrition
HOWARD D. BARTLETT, M.S. (Maine), P.E.	Assoc. Prof. of Agricultural Eng.
JAMES B. BARTOO, Ph.D. (Iowa)	Professor of Mathematics
RONALD A. BARTOO, M.F. (Yale)	Professor of Forestry
THOMAS F. BATES, Ph.D. (Columbia)	Professor of Mineralogy
CARL A. BAUER, Ph.D. (Harvard)	Associate Professor of Astronomy
ROBERT V. BAUER, Ph.D. (Illinois)	Associate Professor of English
SAMUEL P. BAYARD, A.M. (Harvard)	Professor of English
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CLARE A. BECKER, Ph.D. (Cornell)	Prof. of Agricultural Bus. Mgmt.
F. JOSEPH BEDENK, A.M. (Columbia)	Professor of Physical Education
KENNETH R. BEITTEL, D.Ed. (Penn State)	Professor of Art Education
SIMON BELASCO, Ph.D. (Pennsylvania)	Assoc. Prof. of Romance Languages
MAURICE E. BELL, Ph.D. (M.I.T.)	Professor of Geophysics
WILLIAM D. BELL, Ph.D. (Chicago)	Assistant Professor of Botany
EDWARD D. BELLIS, Ph.D. (Minnesota)	Assistant Professor of Zoology
KENNETH R. BENNETT, Ph.D. (Cornell)	Professor of Agricultural Statistics
THOMAS C. BENTON, Ph.D. (Pennsylvania)	Professor of Mathematics
ERNEST L. BERGMAN, Ph.D. (Michigan State)	Asst. Prof. of Plant Nutrition
ASA J. BERLIN, Ph.D. (Northwestern)	Assoc. Prof. of Speech Education
JESSIE BERNARD, Ph.D. (Washington U.)	Professor of Sociology
ROBERT G. BERNREUTER, Ph.D. (Stanford)	Professor of Psychology
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PAUL W. BIXBY, D.Ed. (Columbia)	Professor of Education
ALEX BLACK, Ph.D. (Rochester)	Assistant Director, Agr. Expt. Sta.
ALFRED K. BLACKADAR, Ph.D. (N.Y.U.)	Professor of Meteorology
NORRIS D. BLACKBURN, Ph.D. (Ohio State)	Professor of Entomology
DONALD W. BLEZNICK, Ph.D. (Columbia)	Assoc. Prof. of Romance Languages
JAMES R. BLOOM, Ph.D. (Wisconsin)	Assoc. Prof. of Plant Pathology
BYRON C. BLOOMFIELD, S.M. (M.I.T.)	Assoc. Prof. of Architectural Engineering
HOWARD J. BONSER, Ph.D. (Penn State)	Professor of Rural Sociology Extension
ALFRED L. BORTREE, D.V.M. (Michigan State)	Professor of Veterinary Science
GERALD R. BOSCH, Ph.D. (Michigan State)	Associate Professor of Education
ROBERT V. BOUCHER, Ph.D. (Missouri)	Professor of Agr. and Biol. Chem.
SIDNEY A. BOWHILL, Ph.D. (Cambridge)	Assoc. Prof. of Electrical Engineering
THOMAS D. BOWMAN, M.A. (Penn State)	Professor of English Literature
JOHN S. BOYLE, Ph.D. (Wisconsin)	Assoc. Prof. of Plant Pathology
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JOSEPH F. BRADLEY, Ph.D. (Pittsburgh)	Professor of Finance
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WALTER COUTU, Ph.D. (Wisconsin)	Professor of Sociology
MAURICE B. CRAMER, Ph.D. (Princeton)	Professor of English
ROY G. CREECH, Ph.D. (Purdue)	Assistant Professor of Plant Breeding
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LLOYD A. CURRIE, Ph.D. (Chicago)	Assistant Professor of Chemistry
HASKELL B. CURRY, Ph.D. (Goettingen)	Evan Pugh Res. Prof. of Math.
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ARTHUR F. DAVIS, D.P.H. (Michigan)	Professor of Physical Education
DAVID E. DAVIS, Ph.D. (Harvard)	Professor of Zoology
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HUGH M. DAVISON, Ed.D. (Harvard)	Professor of Educational Research
GEORGE F. DEASY, Ph.D. (Clark)	Professor of Geography
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WARD S. DIETHORN, Ph.D. (Carnegie Tech.)	Asst. Prof. of Nuclear Engineering
CHARLES C. DIILIO, M.S. (Penn State), P.E.	Prof. of Mechanical Engineering
JOSEPH A. DIXON, Ph.D. (Penn State)	Professor of Chemistry
FRANCIS J. DOAN, M.S. (Penn State)	Professor of Dairy Manufacturing
MARY L. DODDS, Ph.D. (Pittsburgh)	Professor of Foods and Nutrition
DOUGLAS J. DONAHUE, Ph.D. (Wisconsin)	Associate Professor of Physics
ALAN B. DRAPER, M.I.E. (Syracuse)	Asst. Prof. of Industrial Engineering
KAJ DRENCK, Ph.D. (Copenhagen)	Associate Professor of Physics
JOSEPH M. DUICH, Ph.D. (Penn State)	Assistant Professor of Agronomy
ROBERT E. DUNHAM, Ph.D. (Ohio State)	Assistant Professor of Speech
JAMES W. DUNLOP, M.Mus. (Michigan)	Professor of Music Education
HOWARD W. DUNNE, Ph.D. (Michigan State)	Professor of Veterinary Science
LOUIS DUPREE, Ph.D. (Harvard)	Associate Professor of Anthropology
ROBERT T. DUQUET, Ph.D. (N.Y.U.)	Assistant Professor of Meteorology
MARJORIE EAST, Ed.D. (Columbia)	Prof. of Home Economics Education
PAUL EBAUGH, A.B. (Denison)	Professor of Engineering Research
EARL E. EDGAR, Ph.D. (Cincinnati)	Professor of Education
ROBERT ENGGASS, Ph.D. (Michigan)	Assoc. Prof. of Hist. of Art and Arch.
ROBERT H. ESSENHIGH, Ph.D. (Sheffield)	Assoc. Prof. of Fuel Technology
BEN EUWEMA, Ph.D. (Chicago)	Dean, College of the Liberal Arts
CORTLAND EYER, Ph.D. (Northwestern)	Professor of Romance Languages
CARL C. FAITH, Ph.D. (Purdue)	Associate Professor of Mathematics
MICHAEL A. FARRELL, Ph.D. (Yale)	Director of Agr. Expt. Sta.
MERRELL R. FENSKE, D.Sc. (M.I.T.)	Professor of Chemical Engineering
CHARLES L. FERGUS, Ph.D. (Penn State)	Prof. of Botany and Plant Pathology
JOHN H. FERGUSON, Ph.D. (Pennsylvania)	Prof. of Pol. Sci. and Pub. Adm.
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## GRADUATE FACULTY

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HUMMEL FISHBURN, Mus.D. (Montreal)	Prof. of Music and Music Ed.
EDWIN R. FITZGERALD, Ph.D. (Wisconsin)	Professor of Physics
GEORGE H. FLEMING, Ph.D. (Penn State)	Professor of Chemistry
HAROLD K. FLEMING, M.S. (Penn State)	Professor of Pomology
PETER W. FLETCHER, Ph.D. (Missouri)	Professor of Forestry
FREDERICK C. FLIEGEL, Ph.D. (Wisconsin)	Asst. Prof. of Rural Sociology
ROBERT J. FLIPSE, Ph.D. (Michigan State)	Assoc. Prof. of Dairy Science
ANTHONY H. FODERARO, Ph.D. (Pittsburgh)	Assoc. Prof. of Nuclear Engineering
DONALD H. FORD, Ph.D. (Penn State)	Assistant Professor of Psychology
PAUL B. FOREMAN, Ph.D. (Vanderbilt)	Professor of Sociology
KENT FORSTER, Ph.D. (Pennsylvania)	Professor of European History
HENRY R. FORTMANN, Ph.D. (Cornell)	Professor of Agronomy
H. SEYMOUR FOWLER, Ph.D. (Cornell)	Assoc. Prof. of Nature and Sci. Ed.
ROBERT W. FRANK, JR., Ph.D. (Yale)	Professor of English
DONALD E. H. FREAR, Ph.D. (Penn State)	Prof. of Agr. and Biol. Chem.
CHARLES M. FREEMAN, Ph.D. (North Carolina State)	Asst. Prof. of Rural Soc. Ext.
ERNEST H. FREUND, Ph.D. (Freiburg)	Professor of Philosophy
JOHN C. FREY, Ph.D. (Iowa State)	Professor of Land Economics
JAMES V. FRICK, Ph.D. (Iowa)	Assoc. Prof. of Clinical Speech
ALINE H. FRINK, Ph.D. (Chicago)	Associate Professor of Mathematics
ORRIN FRINK, Ph.D. (Columbia)	Professor of Mathematics
JAMES J. FRITZ, Ph.D. (California)	Professor of Chemistry
MARLOWE D. FROKE, M.S. (Northwestern)	Associate Professor of Journalism
MARY E. FUQUA, Ph.D. (Ohio State)	Assoc. Prof. of Foods and Nutrition
HELEN S. GALBRAITH, M.A. (Penn State)	Associate Professor of Art
RUTH E. GATES, Ph.D. (Penn State)	Assoc. Prof. of Clothing and Textiles
MICHAEL P. GAUS, Ph.D. (Illinois)	Asst. Prof. of Engineering Mechanics
ROBERT F. GENTRY, Ph.D. (Michigan State)	Professor of Veterinary Science
HENRY D. GERHOLD, Ph.D. (Yale)	Assistant Professor of Forestry
JOHN J. GIBBONS, Ph.D. (Illinois)	Professor of Physics
KARL A. GINGERICH, Dr.rer.nat. (Freiberg)	Assistant Professor of Chemistry
PETER H. GIVEN, D.Phil. (Oxford)	Assoc. Prof. of Fuel Technology
MAURICE S. GJESDAHL, M.S. (Lehigh)	Professor of Mechanical Engineering
JAMES L. GOBBLE, Ph.D. (Penn State)	Assoc. Prof. of Animal Industry
MAURICE K. GODDARD, M.S. (California)	Professor of Forestry
HELMUT J. GOLATZ, M.A. (Temple)	Assoc. Prof. of Industrial Relations
WALTER I. GOLDBERG, Ph.D. (Duke)	Assistant Professor of Physics
LIONEL GOODMAN, Ph.D. (Iowa State)	Associate Professor of Chemistry
JOAN GORDON, Ph.D. (Minnesota)	Professor of Foods and Nutrition
LEON GORLOW, Ph.D. (Columbia)	Associate Professor of Psychology
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WILLIAM H. GOTOLSKI, Ph.D. (Penn State)	Assoc. Prof. of Civil Engineering
RICHARD A. GOTSHALK, Ph.D. (Northwestern)	Assistant Professor of Philosophy
JOSEPH H. GRAHAM, Ph.D. (North Carolina State)	Assoc. Prof. of Plant Path.
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ELMER A. GROSS, D.Ed. (Pittsburgh)	Professor of Physical Education
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LESTER P. GUEST, Ph.D. (Maryland)	Professor of Psychology
GEORGE M. GUTHRIE, Ph.D. (Minnesota)	Professor of Psychology
CHARLES G. HAAS, JR., Ph.D. (Chicago)	Associate Professor of Chemistry
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JOHN F. HALL, Ph.D. (Ohio State)	Professor of Psychology
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ROBERT H. HAMILTON, JR., Ph.D. (Michigan State)	Asst. Prof. of Botany
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WILLIAM L. HARKNESS, Ph.D. (Michigan State)	Asst. Prof. of Mathematics
IRENE E. HARMS, Ph.D. (Iowa)	Professor of Child Development
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BRICE HARRIS, Ph.D. (Harvard)	Professor of English Literature
DALE B. HARRIS, Ph.D. (Minnesota)	Professor of Psychology
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JULES HELLER, Ph.D. (Southern California)	Professor of Art
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GRACE M. HENDERSON, Ph.D. (Ohio State)	Professor of Home Economics
WILLIAM L. HENNING, Ph.D. (Wisconsin)	Professor of Animal Industry
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ALBRECHT W. HUSSMANN, Dr.Ing. (Tech. Univ., Berlin), P.E.	<i>Prof. of Eng. Res.</i>
A. WITT HUTCHISON, Ph.D. (Penn State)	<i>Professor of Chemistry</i>
HARRY K. HUTTON, D.Ed. (Penn State)	<i>Associate Professor of Education</i>
ROBERT F. HUTTON, Ph.D. (Harvard)	<i>Professor of Farm Management</i>
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PHILIP S. KLEIN, Ph.D. (Pennsylvania)	<i>Professor of American History</i>
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JEROME K. PASTO, Ph.D. (Cornell)	Professor of Farm Management
ROBERT B. PATRICK, Ed.D. (Columbia)	Professor of Education
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RUTH L. PIKE, Ph.D. (Chicago)	Professor of Foods and Nutrition
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JOHN E. PIXTON, JR., Ph.D. (Chicago)	Assistant Professor of History
ROBERT M. POCKRASS, Ph.D. (Stanford)	Associate Professor of Journalism
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ERNEST C. POLLARD, Ph.D. (Cambridge)	Professor of Biophysics
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GEORGE N. RANEY, Ph.D. (Columbia)	Associate Professor of Mathematics
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HAROLD J. READ, Ph.D. (Pennsylvania), P.E.	Prof. of Physical Metallurgy
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HARALD SCHRAER, Ph.D. (Cornell)	<i>Associate Professor of Biophysics</i>
CLAYTON H. SCHUG, M.A. (Ohio State)	<i>Professor of Speech</i>
MORTIMER A. SCHULTZ, B.S. (M.I.T.)	<i>Visiting Assoc. Prof. Nuclear Eng.</i>
RALPH P. SEWARD, Ph.D. (Brown)	<i>Professor of Chemistry</i>
MAURICE SHAMMA, Ph.D. (Wisconsin)	<i>Associate Professor of Chemistry</i>
M. G. SHARMA, Ph.D. (Penn State)	<i>Asst. Prof. of Engineering Mechanics</i>
WARD M. SHARP, Ph.D. (Washington U.)	<i>Professor of Wildlife Management</i>
ISADOR M. SHEFFER, Ph.D. (Harvard)	<i>Professor of Mathematics</i>
PHILIP A. SHELLEY, Ph.D. (Harvard)	<i>Prof. of German and Comparative Lit.</i>
PAUL E. SHIELDS, M.S. (Pittsburgh), E.E., P.E.	<i>Assoc. Prof. of Elec. Eng.</i>
JAMES W. SHIGLEY, Ph.D. (Penn State)	<i>Assoc. Prof. of Agr. and Biol. Chem.</i>
BRUCE R. SHOBAKEN, M.F.A. (Minnesota)	<i>Assistant Professor of Art</i>

## GRADUATE FACULTY

SAMUEL SHULITS, M.S. (Michigan College of Mining and Tech.)	<i>Prof. of Civil Eng.</i>
ALBERTA E. SIEGEL, Ph.D. (Stanford)	<i>Assoc. Prof. of Child Development</i>
BRUCE M. SIEGENTHALER, Ph.D. (Michigan)	<i>Prof. of Clin. Speech and Audiology</i>
PETER S. SIGNELL, Ph.D. (Rochester)	<i>Assistant Professor of Physics</i>
RUTH C. SILVA, Ph.D. (Michigan)	<i>Professor of Political Science</i>
PAUL D. SIMKINS, Ph.D. (Wisconsin)	<i>Assistant Professor of Geography</i>
PHILIP S. SKELL, Ph.D. (Duke)	<i>Professor of Chemistry</i>
EUGEN SKUDRZYK, Ph.D. (Berlin)	<i>Professor of Engineering Research</i>
ROBERT L. SLOBOD, Ph.D. (Northwestern)	<i>Prof. of Petroleum and Natural Gas Eng.</i>
CYRIL B. SMITH, Ph.D. (Penn State)	<i>Associate Professor of Plant Nutrition</i>
GORDON R. SMITH, Ph.D. (Penn State)	<i>Associate Professor of English</i>
GRANT W. SMITH, Ph.D. (Minnesota)	<i>Professor of Chemistry</i>
KINSLEY R. SMITH, Ph.D. (Pennsylvania)	<i>Professor of Psychology</i>
WARREN S. SMITH, M.A. (Iowa)	<i>Professor of Theatre Arts</i>
WILLIAM M. SMITH, JR., Ph.D. (Cornell)	<i>Professor of Family Relationships</i>
THOMAS SMYTH, JR., Ph.D. (Johns Hopkins)	<i>Asst. Professor of Entomology</i>
JOHN C. SNOWDON, Ph.D. (London), D.I.C.	<i>Asst. Prof. of Engineering Research</i>
HELEN I. SNYDER, Ph.D. (Illinois)	<i>Assistant Professor of Psychology</i>
WILLIAM U. SNYDER, Ph.D. (Ohio State)	<i>Professor of Psychology</i>
LEO H. SOMMER, Ph.D. (Penn State)	<i>Professor of Chemistry</i>
WILLIAM E. SOPPER, Ph.D. (Yale)	<i>Assistant Professor of Forestry</i>
HERMAN M. SOUTHWORTH, A.B. (Cornell)	<i>Prof. of Agricultural Economics</i>
WILLIAM SPACKMAN, JR., Ph.D. (Harvard)	<i>Professor of Paleobotany</i>
CHARLES M. SPEIDEL, M.S. (Penn State)	<i>Professor of Physical Education</i>
THEODORE S. SPICER, Fuels E. (Penn State), P.E.	<i>Prof. of Min. Prep. Eng.</i>
HOWARD B. SPRAGUE, Ph.D. (Rutgers)	<i>Professor of Agronomy</i>
VANCE G. SPRAGUE, Ph.D. (Wisconsin)	<i>Professor of Agronomy</i>
C. DREW STAHL, Ph.D. (Penn State)	<i>Prof. of Petroleum and Natural Gas Eng.</i>
WILLIAM J. STAMBAUGH, Ph.D. (Yale)	<i>Asst. Professor of Forest Pathology</i>
JAMES L. STARLING, Ph.D. (Penn State)	<i>Assistant Professor of Agronomy</i>
WILLIAM A. STEELE, Ph.D. (Washington)	<i>Associate Professor of Chemistry</i>
ROBERT STEFANKO, Ph.D. (Penn State)	<i>Asst. Prof. of Mining Engineering</i>
F. BRISCOE STEPHENS, Ph.D. (Penn State)	<i>Assoc. Professor of Meteorology</i>
GLENN Z. STEVENS, Ph.D. (Minnesota)	<i>Professor of Agricultural Education</i>
ROBERT W. STONE, Ph.D. (Iowa State)	<i>Professor of Bacteriology</i>
RICHARD G. STONER, Ph.D. (Princeton)	<i>Professor of Physics</i>
RANDALL S. STOUT, Ph.D. (Pittsburgh)	<i>Professor of Economics</i>
WERNER F. STRIEDIECK, Ph.D. (Michigan)	<i>Associate Professor of German</i>
EARL P. STRONG, Ed.D. (N.Y.U.)	<i>Professor of Management</i>
GREENVILLE K. STROTHER, Ph.D. (Penn State)	<i>Asst. Professor of Physics</i>
H. TRACY STURCKEN, Ph.D. (North Carolina)	<i>Assoc. Prof. of Romance Languages</i>
JOSEPH T. SULLIVAN, Ph.D. (Purdue)	<i>Professor of Phytochemistry</i>
SHIOU-CHUAN SUN, Sc.D. (M.I.T.)	<i>Professor of Mineral Preparation</i>
A. BRUCE SUTHERLAND, Ph.D. (Pennsylvania)	<i>Professor of English Literature</i>
FRANK M. SWARTZ, Ph.D. (Johns Hopkins)	<i>Research Prof. of Paleontology</i>
ROBERT W. TAFT, JR., Ph.D. (Ohio State)	<i>Professor of Chemistry</i>
JAMES TAMMEN, Ph.D. (California)	<i>Associate Professor of Plant Pathology</i>
HAROLD I. TARPLEY, M.S. (Illinois), P.E.	<i>Professor of Electrical Engineering</i>
HUGH P. TAYLOR, Ph.D. (California Tech.)	<i>Assistant Professor of Geochemistry</i>
WILLA C. TAYLOR, M.A. (N.Y.U.)	<i>Professor of Music</i>
EDWARD C. THADEN, D.U.P. (Paris)	<i>Assoc. Professor of European History</i>
GEORGE A. THEODORSON, Ph.D. (Cornell)	<i>Associate Professor of Sociology</i>
DENO G. THEVAOS, Ed.D. (Columbia)	<i>Associate Professor of Psychology</i>
GLENN N. THIEL, M.Ed. (Penn State)	<i>Professor of Physical Education</i>
WALTER I. THOMAS, Ph.D. (Iowa State)	<i>Associate Professor of Agronomy</i>



## GRADUATE FACULTY

S. EARL THOMPSON, D.Ed. (Illinois)	<i>Prof. of Hotel and Institution Adm.</i>
GEORGE L. THUERING, M.S. (Penn State), M.E., P.E.	<i>Prof. of Industrial Eng.</i>
THOMAS T. THWAITES, Ph.D. (Rochester)	<i>Assistant Professor of Physics</i>
GERALD M. TORKELSON, D.Ed. (Penn State)	<i>Professor of Education</i>
HOWARD O. TRIEBOLD, Ph.D. (Minnesota)	<i>Prof. of Agr. and Biol. Chem.</i>
ALFRED A. TRIOLO, Ph.D. (Illinois)	<i>Asst. Professor of Romance Languages</i>
CLARENCE E. TROTTER, Ph.D. (Minnesota)	<i>Assoc. Professor of Marketing</i>
ALBERT G. TSUGAWA, Ph.D. (Michigan)	<i>Asst. Professor of Philosophy</i>
LOREN D. TUKEY, Ph.D. (Ohio State)	<i>Associate Professor of Pomology</i>
O. FRANK TUTTLE, Ph.D. (M.I.T.)	<i>Professor of Geochemistry</i>
WARREN N. UNDERWOOD, C.E. (Princeton), P.E.	<i>Assoc. Prof. of Civil Engineering</i>
HUGH B. URBAN, Ph.D. (Penn State)	<i>Assistant Professor of Psychology</i>
VLADIMIR VAND, D.Sc. (Glasgow)	<i>Professor of Physics</i>
ABRAM W. VANDERMEER, Ph.D. (Chicago)	<i>Professor of Education</i>
EDWARD B. VANORMER, Ph.D. (Columbia)	<i>Professor of Psychology</i>
FRANCIS J. VASTOLA, Ph.D. (Penn State)	<i>Asst. Prof. of Fuel Technology</i>
JEANNETTE VEATCH, Ph.D. (N.Y.U.)	<i>Associate Professor of Education</i>
DOROTHY H. VEON, Ed.D. (Columbia)	<i>Professor of Education</i>
ROBERT K. VIERCK, M.S. (Iowa), P.E.	<i>Professor of Engineering Mechanics</i>
CARL VOLZ, Ph.D. (Penn State)	<i>Professor of Electrical Engineering</i>
JAMES B. WADSWORTH, Ph.D. (Harvard)	<i>Assoc. Prof. of Romance Languages</i>
HERBERT A. WAHL, Ph.D. (Penn State)	<i>Professor of Botany</i>
DARRELL E. WALKER, Ph.D. (California)	<i>Assoc. Professor of Plant Breeding</i>
PHILIP L. WALKER, JR., Ph.D. (Penn State)	<i>Professor of Fuel Technology</i>
WALTER H. WALTERS, Ph.D. (Western Reserve)	<i>Professor of Theatre Arts</i>
HAROLD V. WALTON, M.S. (Penn State)	<i>Prof. of Agricultural Engineering</i>
JOHN M. WARREN, Ph.D. (Wisconsin)	<i>Assoc. Professor of Psychology</i>
THOMAS WARTIK, Ph.D. (Chicago)	<i>Professor of Chemistry</i>
JOHN B. WASHKO, Ph.D. (Wisconsin)	<i>Professor of Agronomy</i>
R. HADLY WATERS, Ph.D. (Pennsylvania)	<i>Professor of Transportation</i>
GEORGE H. WATROUS, JR., Ph.D. (Penn State)	<i>Assoc. Prof. of Dairy Mfg.</i>
ARTHUR H. WAYNICK, Sc.D. (Harvard)	<i>Professor of Electrical Engineering</i>
WAYNE WEBB, Ph.D. (Iowa)	<i>Professor of Physics</i>
ROBERT L. WEBER, Ph.D. (Penn State)	<i>Associate Professor of Physics</i>
STANLEY WEINTRAUB, Ph.D. (Penn State)	<i>Assistant Professor of English</i>
WINSTON R. WEISMAN, Ph.D. (Ohio State)	<i>Prof. of Hist. of Art and Arch.</i>
ARTHUR M. WELLINGTON, M.A. (Ohio State)	<i>Prof. of Counselor Education</i>
CLIFFORD C. WERNHAM, Ph.D. (Cornell)	<i>Professor of Plant Pathology</i>
WOLDEMAR WEYL, Dr.Ing. (Aachen)	<i>Evan Pugh Res. Prof. of Phys. Sci.</i>
FRANCIS L. WHALEY, Ph.D. (Michigan)	<i>Associate Professor of Psychology</i>
RALPH H. WHERRY, M.A. (Penn State), C.L.U.	<i>Professor of Insurance</i>
BENJAMIN A. WHISLER, Sc.D. (Harvard), P.E.	<i>Professor of Civil Engineering</i>
EUGENE E. WHITE, Ph.D. (Louisiana State)	<i>Associate Professor of Speech</i>
WALLACE E. WHITE, Ph.D. (Yale)	<i>Professor of Wood Technology</i>
DELPHA E. WIESENDANGER, M.S. (Cornell)	<i>Prof. of Home Mgmt. and Housing</i>
THOMAS A. WIGGINS, Ph.D. (Penn State)	<i>Associate Professor of Physics</i>
MELVIN A. WILKOV, Ph.D. (Penn State)	<i>Asst. Prof. of Eng. Mechanics</i>
MARY L. WILLARD, Ph.D. (Cornell)	<i>Professor of Chemistry</i>
EUGENE G. WILLIAMS, Ph.D. (Penn State)	<i>Associate Professor of Geology</i>
WILLIAM A. WILLIAMS, Ed.D. (Pittsburgh)	<i>Professor of Industrial Education</i>
MERRITT A. WILLIAMSON, Ph.D. (Yale), P.E.	<i>Professor of Engineering</i>
WILLIAM O. WILLIAMSON, Ph.D., D.Sc. (London)	<i>Assoc. Prof. of Cer. Tech.</i>
DONALD J. WILLOWER, Ed.D. (Buffalo)	<i>Assistant Professor of Education</i>
CLYDE J. WINGFIELD, D.P.A. (Syracuse)	<i>Asst. Prof. of Pol. Sci. and Pub. Adm.</i>
ROLF C. WINTER, D.Sc. (Carnegie Tech.)	<i>Associate Professor of Physics</i>



## GRADUATE FACULTY

GEORGE F. WISLICENUS, Ph.D. (California Tech.), P.E.	<i>Prof. of Aero. Eng.</i>
MERRILL WOOD, M.S. (Penn State)	<i>Assoc. Professor of Zoology</i>
ARTHUR E. WOODWARD, Ph.D. (Brooklyn Polytech.)	<i>Assoc. Professor of Physics</i>
RICHARD N. WORK, Ph.D. (Cornell)	<i>Assoc. Professor of Physics</i>
HAROLD D. WRIGHT, Ph.D. (Columbia)	<i>Assoc. Professor of Mineralogy</i>
JAMES E. WRIGHT, JR., Ph.D. (Cornell)	<i>Professor of Genetics</i>
LAUREN A. WRIGHT, Ph.D. (California Tech.)	<i>Professor of Geology</i>
KELLY YEATON, M.A. (Washington)	<i>Assoc. Professor of Theatre Arts</i>
PHILIP YOUNG, Ph.D. (Iowa)	<i>Professor of American Literature</i>
MARTIN L. ZEIGLER, Ph.D. (Penn State)	<i>Research Assoc. in Psychology</i>
HAROLD P. ZELKO, M.A. (Ohio State), LL.B.	<i>Professor of Speech</i>
LEONARD N. ZIMMERMAN, Ph.D. (Cornell)	<i>Assoc. Professor of Bacteriology</i>
HARRY D. ZOOK, Ph.D. (Penn State)	<i>Professor of Chemistry</i>
GEORGE S. ZORETICH, M.A. (Penn State)	<i>Professor of Art</i>

## LECTURERS

ATAM ARYA, Ph.D. (Penn State)	<i>Visiting Research Assoc. in Physics</i>
CHARLES D. AUVENSHINE, M.Ed. (Missouri)	<i>Instructor in Education</i>
LELAND L. BEIK, Ph.D. (Columbia)	<i>Assoc. Professor of Marketing</i>
JOHN W. CATALDO, M.A. (Columbia)	<i>Assoc. Professor of Art Education</i>
PAUL EDMONSTON, Ph.D. (Ohio State)	<i>Asst. Professor of Art Education</i>
ALFRED J. ENGEL, B.Ch.E. (Cornell)	<i>Asst. Prof. of Chemical Engineering</i>
THOMAS IWAND, Ph.D. (Oregon)	<i>Assistant Professor of Economics</i>
OSCAR A. KIMMEL, M.S. (Penn State)	<i>Asst. Prof. of Farm Mechanics</i>
J. CAMPBELL LESTER, M.S. (Penn State), P.E.	<i>Assoc. Prof. of Mechanical Eng.</i>
NELL A. MURPHY, D.Ed. (Stanford)	<i>Associate Professor of Education</i>
VINCENT P. NORRIS, Ph.D. (Illinois)	<i>Asst. Professor of Advertising</i>
JOHN M. SHEMICK, M.A. (Michigan State)	<i>Assoc. Prof. of Industrial Arts Ed.</i>
MARVIN R. SUSSMAN, Ph.D. (Michigan)	<i>Assistant Professor of Finance</i>
ARTHUR T. THOMPSON, S.M. (Harvard)	<i>Professor of Engineering Research</i>
BURTON E. VOSS, Ph.D. (Iowa State)	<i>Assistant Professor of Education</i>
WALTER F. WESTERFELD, M.S. (Penn State)	<i>Asst. Professor of Botany</i>

# GENERAL INFORMATION

GRADUATE WORK at The Pennsylvania State University was first offered in 1862 when two graduate students were in residence. It was given more formal recognition in 1864 by the establishment of a "course for Graduates" designed for students who, after receiving the degree of Bachelor of Scientific Agriculture, wished to do advanced work leading to the degree of Master of Scientific Agriculture. For some time there were few graduate students, and graduate instruction was relatively unorganized. Later a committee of the University Senate was given the responsibility of establishing standards and regulations governing graduate work and the granting of advanced degrees. The Graduate School was organized in 1922. Until this time only masters' degrees and certain technical degrees had been conferred. In 1924 the Board of Trustees authorized the granting of the degree of Doctor of Philosophy. Still later other degrees were approved.

The faculty of the Graduate School consists of the President and certain other general administrative officers of the University, the Deans, the Librarian, the heads of departments, and those members of the instructional staff who have been authorized by the proper agencies of the Graduate School to offer graduate courses and supervise research leading to theses. It controls all academic matters pertaining to the Graduate School, subject to review by the University Senate.

The Graduate Faculty has approximately 700 members. Graduate student enrollment was about 2,500 per semester in 1960-61 and about 2,700 during the summer of 1961. The number of advanced degrees conferred in 1960-61 was 907, of which 174 were doctorates.

CO-OPERATIVE ARRANGEMENTS WITH OTHER INSTITUTIONS—A working arrangement has been established with Jefferson Medical College of Philadelphia whereby a candidate for an advanced degree at Jefferson may do part of his graduate work at Penn State by scheduling relevant courses and research at University Park. Similarly a graduate student with an appropriate major at Penn State may earn credits at Jefferson which, upon advance approval by his major department, will be accepted in partial fulfillment of degree requirements at Penn State.

A co-operative agreement with the University of Pittsburgh enables a student at Penn State to spend one trimester taking courses and doing field work at the Graduate School of Public Health of the University of Pittsburgh in partial fulfillment of the requirements for the M.S. degree with a major in Nutrition in Public Health.

## PROCEDURES AND REGULATIONS

A student is expected to assume full responsibility for knowing the regulations and pertinent procedures of the Graduate School as set forth in this publication, the *Manual for Graduate Students*, and the *Thesis Information Bulletin*, and for meeting the standards and requirements expressed by these regulations. The *Manual*, which is available to a student after he has been admitted, sets forth in more detail the procedures governing registration, changes in program, and graduation, and gives other information about the Graduate School which is useful to graduate students. Every student should secure a copy from the Dean's office soon after admission.

## ADMISSION

An applicant for admission to the Graduate School should understand that graduate work is not simply an extension of undergraduate work. It operates at a definitely higher level, demands scholarship of a high order, and emphasizes research and crea-



## ADMISSION

tivity. It involves a minimum of formal requirements and regulations, and a maximum of student initiative and responsibility.

A student does not become a graduate student merely by enrolling for advanced courses after having received a baccalaureate degree. Formal admission to the Graduate School is required. Credits earned before admission cannot be applied to meet degree requirements at a later date even though admission may have been granted in the meantime.

Admission is granted by the Dean of the Graduate School after approval of the application by the department in which the student plans to do his major work. Blanks to be used in making formal application for admission can be obtained from the Graduate School office. In general, a student may begin his graduate work in fall, winter, spring, or summer. Prospective students may write directly to the head of any department concerning graduate work in that specific field.

Students from other countries are encouraged to write to the Director of International Student Affairs for information concerning finances, housing, and other non-academic matters.

**CREDENTIALS**—An applicant for admission should provide complete credentials, in duplicate, sent directly from other institutions to the Dean of the Graduate School at least six weeks prior to the opening of the term in which he plans to begin his graduate program. If the applicant has attended more than one institution, two official transcripts of the work covered at each institution are required. This applies to the complete academic record, both undergraduate and graduate.

A student with a slight deficiency in undergraduate preparation may be admitted and allowed to take a limited number of undergraduate courses to make up the deficiency while proceeding with his graduate program. Courses taken for this purpose do not, of course, apply toward the requirements for an advanced degree.

**UNQUALIFIED ADMISSION**—For unqualified admission to the Graduate School an applicant must have received a baccalaureate degree from an accredited institution, earned under residence and credit conditions substantially equivalent to those required by The Pennsylvania State University. He must have maintained during his junior and senior years a minimum grade point average equivalent to 2.5 on The Pennsylvania State University grading scale (approximately half B and half C). Finally, he must ordinarily have completed in a satisfactory manner a certain minimum of course work in designated areas, the specific courses and amount of required work depending upon the field of advanced study which the student proposes to enter. The minimum grade point average of 2.5 during the last two undergraduate years is a general requirement of the Graduate School. Individual departments may require a higher average for admission in their fields.

The above requirements apply particularly to the student who has recently completed an undergraduate program and is about to begin graduate study. An applicant who has done a year or more of graduate work in a recognized graduate school will be evaluated largely on the basis of the graduate record but with some attention to undergraduate achievement. For a mature person, recognized attainment in a professional field will be considered, and reduced weight will be given to old undergraduate records.

**CONDITIONAL ADMISSION**—Some divisions are participating in an experiment on conditional admission for applicants whose undergraduate grade point average is below 2.5 but whose qualifications in other respects seem to suggest probable success in the Graduate School. Such an applicant must realize that the initiative rests entirely with him in communicating with the department of his chosen major and that, if admitted conditionally, he does graduate work at his own risk. There is no assurance that he will subsequently be granted unqualified admission or that the credits earned will be applicable toward degree requirements. Applicants for admission on a conditional basis must have all of the essential materials for consideration for admission



to that status on file with the Dean of the Graduate School at least six weeks before they wish to register in the Graduate School.

**PROVISIONAL ADMISSION**—Provisional admission may be granted to an applicant whose complete credentials are not available at the time of registration, but this admission will be subject to cancellation if the credentials, on their arrival, do not meet the requirements for admission to the Graduate School. Also, while the applicant is holding provisional admission, certification of any scheduled credits will be withheld until receipt of his official credentials makes possible his unqualified admission to the Graduate School. If the provisional admission should, for any reason, be canceled, the student is thereby automatically dropped from the Graduate School and as a consequence will be required to cease attending any 500-level courses for which he may have registered. He may continue to attend 400-level courses provided he applies for and is accepted for registration as a special student.

**ADVISERS**—To assist the student in planning his program, the head of his major department will designate a member of the faculty to serve as adviser. It is the student's responsibility to secure the name of his adviser from the department head and to seek a conference before registration.

**READMISSION**—Formal readmission is not required year by year nor after one or more terms of absence from the campus unless the student has completed more than 12 credits of work at another institution in the meantime. In this case readmission is required, and evidence of good standing at the institution involved is essential. A student who has earned a master's degree at The Pennsylvania State University should not register for further degree work until his academic record and personal qualifications have been reviewed critically by the department of his major interest and a candidacy evaluation has been completed.

**ENGLISH PROFICIENCY OF FOREIGN STUDENTS**—Entering graduate students from countries other than the United States are required to demonstrate high level competence in the use of the English language, including reading, writing, speaking, and listening. Upon arrival at the University, such students are requested to make an appointment for an initial language proficiency interview at the Language Testing Center for International Students, 218 Sparks Building. Students with an obviously good command of English will be exempted from formal testing; others will be scheduled for a series of proficiency tests. Remedial work will be prescribed as indicated by the tests.

**GUESTS OF THE UNIVERSITY**—The President of the University, on recommendation of the Dean of the Graduate School, will welcome doctors of philosophy of The Pennsylvania State University, as well as those of other accredited colleges and universities, as guests of the University, with the privilege of attending seminars and courses and of carrying on research. There will be no charge except for laboratory expenses. Arrangements should be made in advance with the Dean of the Graduate School.

**UNDERGRADUATE STUDENTS**—A senior student of The Pennsylvania State University lacking not more than 4 credits for graduation may be admitted to the Graduate School. This limit may be increased to 8 credits in the case of a student with an average of at least B (a grade point average of 3). Any senior with a 3.5 grade point average may be admitted to 500-level courses with the consent of the instructor; other undergraduate students may be admitted to such courses with the consent of the instructor and the Dean of the Graduate School. Those not admitted to the Graduate School cannot use these credits toward an advanced degree.

## RETENTION

The University expects that students will conduct themselves in accordance with the standards normally followed by educated men and women and in accord-

## CLASSIFICATION

ance with the laws of the Nation, State, and Borough. The right is reserved to sever at any time the University connection of any student whose influence is found to be injurious to the standard of morals and scholarship of the student body, or whose conduct is prejudicial to the good name of the University.

A graduate student who fails to maintain satisfactory scholarship may be dropped from the University.

## CLASSIFICATION

At the time of admission to the University students are classified as regular graduate, general graduate, special, or undergraduate students depending upon their objectives and qualifications.

A change in classification for a graduate student is arranged through the Graduate School office and, in the case of a change from general to regular status, the approval of the head of the major department in which the student proposes to work is required.

A person holding a baccalaureate degree and working only for permanent certification as a teacher or administrator in the public schools is advised to apply for admission as a general graduate student.

**REGULAR GRADUATE STUDENTS**—Persons who plan to become candidates for advanced degrees at The Pennsylvania State University and have been formally admitted for advanced study in a particular field are designated as regular graduate students. The program of study is developed under the guidance of a department head or his representative.

It should be emphasized that a student is not a "regular graduate student" unless he has been officially admitted to that status. Regular attendance in the Graduate School, or personal plans for future degree candidacy, do not in themselves carry with them the status or privileges of a regular graduate student.

A regular graduate student who has passed a candidacy evaluation is classified as a doctoral candidate.

**GENERAL GRADUATE STUDENTS**—An applicant who meets all requirements for admission to the Graduate School, but who does not wish to work for an advanced degree at this institution, may arrange for a program of work as a general graduate student. This classification includes those who plan to transfer credits to another institution and those who plan a special program of study not leading to an advanced degree.

The adviser for a general graduate student is appointed by the department head most closely associated with the student's field of interest. The student's status and standing will be reviewed by the Dean of the Graduate School at each registration. He may remain a general graduate student longer than one term only with the permission of the Dean, and for definite and good reasons.

When a general graduate student wishes to become a regular graduate student—i.e., to work for an advanced degree at this institution—he should make application to the Dean of the Graduate School for change of status. His undergraduate record will then be re-evaluated to determine whether or not he is prepared to undertake graduate work for a degree in the major field of his choice. He should understand that he may thereafter apply toward degree requirements only those credits earned as a general graduate student which fit definitely and logically into an integrated degree program. There is no upper limit to the number of credits that may be so applied; neither is there a guarantee that any such credits may be applicable.

**SPECIAL STUDENTS**—A special student is not a graduate student, inasmuch as he has not been admitted to the Graduate School, and may not register for graduate courses or research (500 and 600 series) without permission of the Dean of the Graduate School. A special student may register for 400-level courses, provided he



has attained at least junior standing in college. Except for most unusual reasons a special student who is later admitted to the Graduate School may not then count toward degree requirements any credit earned while in the special student status.

## REGISTRATION

The responsibility for being properly registered rests with the student. At least until he has met the minimum requirements for his degree, he must register for each term in which he proposes to do either course work or research, or other work on his thesis, either on or off campus. In the case of research the number of credits shall be determined by the amount of time required for the investigation, one credit representing one week of full-time graduate work.

**PROCEDURE**—For each registration the student, in consultation with his adviser, prepares a schedule of courses and research designed to fit his individual needs, which is submitted to the Dean of the Graduate School for his approval. The registration process is completed in the manner specified for all students at the University.

Under certain conditions credit may be earned by work done off the campus. A student contemplating such work should inquire of the Dean of the Graduate School about the procedures and conditions. Such work must be scheduled *in advance* in the regular manner.

A resident student is required to register in person, not by proxy. A nonresident student is expected to assume responsibility for initiating the registration process, but the details can be handled by mail.

A student must register for courses audited as well as for those taken for credit.

**EXCEPTIONS**—When a candidate has met minimum requirements for a degree, further registration shall be required only for course work, project work, and research work requiring the use of University facilities and supplies (including laboratory, library, and others). This means, for instance, that if a student has completed nine terms of work (90 credits) of a doctoral program, has completed his research on campus, and has permission from the Dean to complete his work *in absentia*, he need not register for credits. Similarly, a student who has earned 90 credits, but who still has much research to do which does *not* involve using University facilities, and who receives permission to complete his work at, for example, the Library of Congress, need not register. On the other hand, a student who uses University facilities for all of his research must be registered for credit at all times, regardless of the number of credits that may accrue before he completes his work.

A candidate need not register for the term at the end of which the degree is to be conferred solely for the purpose of graduating. He will, of course, be required to register if he has a significant amount of work to complete unless relieved of this obligation by the previous paragraph. He will not be required to register if he has only minor revisions of his thesis to complete and/or the final oral examination to pass.

**TIME OF REGISTRATION**—The regular registration days are indicated in the University Calendar. Graduate students follow the same registration schedule as undergraduates do.

A student is expected to complete his registration during the officially designated period and to attend the first meeting of all classes in which he is enrolling. If this is impossible because of some emergency or unusual circumstance beyond his control, the student may be granted permission by his instructors to miss a few class meetings, it being understood that work missed will be made up subsequently. Under these conditions the Dean of the Graduate School may grant the student permission to register late. In general, a student who receives permission to register late will be required to reduce his program in proportion to the amount of time which he has been absent.



## ACADEMIC LOAD

Regardless of when he may begin attending classes, a student who fails to complete the process of registration within the officially designated registration period will be liable for the late registration charge.

**LOADS, ACADEMIC AND EMPLOYMENT**—Many students depend upon part-time employment to help meet their expenses. A student who is thus employed, however, must recognize the time demands of his work schedule in planning his academic program.

The University takes the position that the facilities of the Graduate School should be made available only to students who can profit from their Graduate School experience to a maximum extent. Therefore the Graduate School reserves the right to deny admission or registration to part-time students who (a) propose schedules of few credits which seem to reflect little real interest in graduate work or would not seem to require serious effort, or (b) wish to carry overloads of such proportion as to handicap them seriously in achieving maximum quality in their graduate work.

“Doing graduate work” means more than doing what is required in courses or in research. It means living in a scholarly atmosphere and seriously engaging in scholarly pursuits. It means profiting from hearing visiting scholars and artists and from engaging in discussions, both formal and informal, with faculty members and fellow students. It should mean leisure time for reflection and for exploring fields related to, although not directly a part of, one’s specialty. Overloads make it difficult and often impossible to do graduate work so conceived. Hence the following “protective” schedule of permitted loads for employed students has been adopted:

EMPLOYMENT		CREDITS ALLOWED	
<i>Hours per Week</i>	<i>Percentage of Full Time</i>	<i>Credits</i>	<i>Percentage of Full Load</i>
0	0	8-10	100
10	25	7-9	80
20	50	5-7	60
30	75	4-5	50
40	100	1-4	40

This means, for example, that anyone working 20 hours per week (about half-time) whether as a half-time graduate assistant, as an employee on campus, or as an employee off-campus, will be limited in the amount of graduate work for which he may register to about three fifths (or 60 per cent) of a normal full-time load (i.e., to 5-7 credits). The word employment is used in a very general sense and includes working for indirect compensation, such as housekeeping, working in the family business, maintaining a large vegetable garden, etc. Hence, all students who are thus employed will be expected to adjust their academic loads accordingly. Exceptions, in the case of students who have demonstrated unusual ability, must be arranged with the Dean of the Graduate School at the time of registration. (See also Auditing and Visiting Classes.)

A student holding a fellowship, graduate assistantship, or scholarship may not accept employment of any kind for service beyond that specified by his appointment.

**AUDITING AND VISITING CLASSES**—A regularly registered graduate student who wishes to take a course without credit may be allowed to do so upon securing the permission of the instructor in the course and the approval of the Dean of the Graduate School. Such a student, known as an auditor, may, if he wishes, participate in class discussion, do practicum work, submit written work, and take examinations. He must register for the course in the same manner as if he were taking the course for credit and must pay tuition on the same basis. He receives no grade in the course

## GRADING SYSTEM

and cannot subsequently claim any credit for work done in the course. Ordinarily a student is required to count courses audited as part of his normal credit load.

With the permission of the instructor, a graduate student may at any time during a term for which he is registered visit a class for which he is not registered. Under this provision the student may not claim the usual privileges of class membership, such as participating in class discussion, doing practicum work, submitting written work, and taking examinations. This privilege is officially designated as "visiting classes without registration," and no record of it appears on the student's transcript.

**STATUS UNDER SELECTIVE SERVICE**—As soon as an applicant has been admitted to the Graduate School, his local board will be informed *provided* the applicant requests it and has given the necessary information. As soon as he receives notification of admission, the applicant should check with the Associate Registrar to see that everything is in order.

A student is certified to be a full-time student insofar as Selective Service is concerned if he schedules at least 8 credits in a term, or if he holds an appointment as a quarter-time or half-time graduate assistant, or if he is serving an internship under approved conditions.

Whenever a student changes his status so as no longer to be considered a full-time student, fails to make satisfactory progress, or makes a drastic change in his declared goal, his local board will be notified.

## GRADING SYSTEM

A grade is given solely on the basis of the instructor's judgment as to the student's scholarly attainment.

For graduate courses (500 series) and for research or thesis (600 or 610) one of three grades may be given:

H for Honors, indicating definitely superior attainment.

P for Pass, indicating acceptable but not superior attainment.

F for Fail, indicating failure to attain the acceptable minimum standard of work or to spend an adequate amount of time doing the work scheduled.

In addition to the quality grades listed above, two symbols, "deferred" and R, may appear on a student's transcript. If work is incomplete at the end of a term for a reason beyond the student's control, or if very little work remains to be done, the instructor may report "deferred" in place of a grade, which will appear temporarily on the student's record.

In the case of thesis work, either in progress or completed, the instructor may report the symbol R in place of a grade. This symbol indicates that the student has devoted an adequate amount of time to the work scheduled but gives no indication of its quality. An R remains on the student's transcript permanently. If, after having submitted a series of R symbols, the instructor reports a grade of H, P, or F for a specific term, this grade is considered to apply to the preceding series of registrations and to denote the quality of that entire series.

For 400 series courses one of five grades may be given:

<i>Grade</i>	<i>Percentage Equivalent</i>	<i>Grade Point Equivalent</i>
A	90-100	4
B	80- 89	3
C	70- 79	2
D	60- 69	1
F (Failure)	0- 59	0

Grades below B do not carry graduate credit and are considered failures in the program of a graduate student.



## TUITION AND CHARGES

### GRADUATION

It is the responsibility of the student to inform the Graduate Recorder of his intention to graduate, and to pay thesis fees at the beginning of the term when he expects to receive an advanced degree. Deadlines are given in the calendar.

Attendance at commencement exercises is expected, but permission to receive the degree *in absentia* may be granted by the Dean of the Graduate School for sufficient reasons. See the *Manual for Graduate Students* for a detailed statement of procedure concerning graduation.

All degrees conferred are tentative until final grade reports have been received even though the student's name may have appeared in the commencement program.

## TUITION AND CHARGES

The University reserves the right to revise the schedule of tuition and charges without further notice.

### TUITION

*Residents of Pennsylvania*, \$22 per credit with a maximum of \$175 per term.

*Nonresidents of Pennsylvania, on-campus work*, \$44 per credit with a maximum of \$350 per term.

*Nonresidents of Pennsylvania, research in absentia*, \$22 per credit with a maximum of \$175 per term.

*Total charge for Vocational Education courses* (indicated by "v" following the course number), \$22.

Tuition is the same for courses whether taken as an auditor or for credit.

Any student who does not fulfill payment obligations promptly may be charged a late payment fee of \$25. A student whose account is delinquent for more than 10 days is subject to suspension from the University.

Whenever it appears that an applicant for admission is not domiciled in Pennsylvania it is assumed that he is a non-Pennsylvanian. If the student who is thus admitted believes that his circumstances do not justify his classification as a non-Pennsylvanian, he may petition the Dean of Admissions for reclassification.

When a petition for reclassification is made, the petitioner is required to present proof of a bona fide continuous domicile of the one admitted (or of his parents, if he is a minor) within the Commonwealth for a period of at least 12 months immediately preceding the date of such petition for reclassification; and, in addition, such other evidence as is pertinent to a complete review of his classification.

Any student who changes his domicile while attending the University is subject to reclassification effective at the beginning of the first term following the twelfth month after such change has taken place.

**TUITION REFUND POLICY**—Charges for tuition are refundable upon withdrawal from the University only in the event the student obtains an Official Withdrawal Form at the office of the Dean of the Graduate School and presents it, together with the student identification and activities card, at the office of the Fee Assessor not later than one calendar month after the effective date of withdrawal from classes. Students who meet these conditions are entitled to receive refunds of charges for tuition for the term in accordance with the following schedule:

Refund of 50 per cent upon withdrawal before the end of the second week of the term. No amount will be refunded for withdrawal after the 14th consecutive calendar day from the first day of classes.



## LIVING ACCOMMODATIONS

The University will not release any refund of tuition until at least three weeks have elapsed from the date the payment was received. All refunds will be made by check and mailed to the student's home address.

**SPECIAL CHARGES** (payable as occasion demands and applicable to all students):

Admission to the Graduate School .....	\$10.00
Privilege of late registration .....	10.00
Change of schedule, each change .....	2.00
Microfilming of doctoral thesis and publication of abstract .....	35.00
Minimum fee for binding of thesis, per copy .....	3.00
Official transcript of record (with seal), each copy .....	1.00

**MOTOR VEHICLE CHARGES**—Each graduate student who possesses, maintains, or operates a motor vehicle (including motorcycles, motor bikes, motor scooters, or any other motor-driven vehicle) in Centre County is required to register such vehicle with the Traffic Violations Officer during the registration period of each term. There is no charge for registration for students who do not desire campus driving or parking privileges. Failure to register a vehicle renders a student liable for a fine of \$25 for each offense.

A permit allowing driving and parking on the campus throughout the week costs \$10 per term. A more restricted permit allowing driving and parking on the campus for evenings and weekends only costs \$3.50 per term.

A graduate assistant pays no fee for the privilege of driving and parking on the campus but is required to comply with student regulations concerning motor vehicles.

A graduate student planning to operate a motor vehicle in the State College area should secure a copy of the leaflet *Parking and Traffic Regulations* from the Traffic Violations Officer, Room 203D Hetzel Union Building.

## LIVING ACCOMMODATIONS

Eastview Terrace and Graduate Circle, both located on the eastern side of the campus, provide one- and two-bedroom apartments for married graduate students.

The Eastview Terrace apartments are fireproof, one-story, steel framework buildings. Forty-six one-bedroom units rent for \$65 per month and 32 two-bedroom units rent for \$75. The rent includes utilities except for electricity. Hot water is heated electrically. The units are unfurnished except for electric stove and refrigerator. For each two units, there is a utility room with two stationary laundry tubs and storage space.

Graduate Circle, opened in 1960, has 144 one-bedroom and 72 two-bedroom apartments in 16 two-story buildings of brick and frame construction. The units rent for \$82.50 and \$92.50 per month, including all utilities. The kitchens have double stainless steel sinks with disposal unit, a gas stove, kitchen cabinets, electric refrigerator, and a built-in chest of drawers in the bedroom; otherwise the units are unfurnished. There are no facilities for private washing machines in the apartments; however, coin-operated laundries at nominal fees are provided in five of the buildings throughout the area. A storage locker is also provided for each apartment at the laundry location.

Families with children of school age cannot be considered for occupancy in Eastview Terrace and Graduate Circle. The one-bedroom apartments are designed for a husband and wife and the two-bedroom units for a family with not more than two children. An application form for a Married Student Apartment may be obtained by writing to the Department of Housing and Food Services, Pollock Dining Hall, The Pennsylvania State University, University Park, Pa.

A married student may also find accommodations in off-campus apartments, trailers, or rooms in private homes.

## STUDENT AIDS

Irvin Hall and Grange Hall, both located on central campus, provide for single students, both men and women. For detailed information write to Department of Housing and Food Services, Pollock Dining Hall, The Pennsylvania State University, University Park, Pa. Other living accommodations are available, including rooms in private homes and lodging houses. The cost varies considerably depending upon the type of accommodation. The prospective student should make arrangements well in advance of the beginning of classes because it may be very difficult to find a convenient location at the last minute. Boarding houses, restaurants, and the Hetzel Union Cafeteria on the campus are available for meals.

## STUDENT AIDS

In every case in which a graduate assistantship, fellowship, grant-in-aid, or scholarship for the next academic year is offered to an actual or prospective graduate student, the student, if he indicates his acceptance before April 15, will have complete freedom through April 15 to submit in writing a resignation of his appointment in order to accept one elsewhere. However, an acceptance given or left in force after April 15 commits him not to accept another appointment without first obtaining formal release for the purpose.

## ASSISTANTSHIPS

Approximately 800 graduate assistantships are awarded annually. Most of these are half-time, but a limited number of quarter-time and three-quarter-time assistantships are available in some departments. An appointee may serve as an assistant in classroom or laboratory instruction, or in research or other work.

A prospective student should write directly to the head of his major department for information and application forms. Appointments are made upon the recommendation of the department head, subject to admission to the Graduate School. Clear evidence of superior ability and promise is required. Reappointment to an assistantship requires a continuing demonstration of good scholarship.

The assistantships vary as follows:

**QUARTER-TIME**—The student may schedule 7-9 credits, receives a stipend in the range \$219-\$375 plus a grant-in-aid which covers tuition, will be required to give about 10 hours of service per week for 12 weeks, and will be considered to be following a full-time course of instruction under Selective Service regulations.

**HALF-TIME**—The student may schedule 5-7 credits, receives a stipend in the range \$438-\$750 plus a grant-in-aid which covers tuition, will be required to give about 20 hours of service per week for 12 weeks, and will be considered to be following a full-time course of instruction under Selective Service regulations.

**THREE-QUARTER-TIME**—The student may schedule 4-5 credits, receives a stipend in the range \$657-\$1,125 plus a grant-in-aid which covers tuition, will be required to give about 30 hours of service per week for 12 weeks, and will be considered a part-time student.

In addition to receiving a grant-in-aid to cover full tuition during the term of appointment, a graduate assistant who is completing three or more consecutive terms of service is entitled to apply for a grant-in-aid to cover tuition for the succeeding term without service. To receive this privilege a student must apply to the head of the department in which he has held the assistantship.

A graduate assistant may not accept additional employment, either at the University or elsewhere, during the period for which service to the University is required under the appointment.



A graduate assistant pays no fee for the privilege of driving and parking on the campus but is required to comply with student regulations concerning motor vehicles.

## FELLOWSHIPS

More than 100 fellowships are awarded annually. Recipients must be superior students and are frequently required to have completed a certain minimum of graduate work before being eligible for an award. Fellows carry a full-time graduate program, receive a stipend which varies with the award, and receive a grant-in-aid paid by the donor of the fellowship to provide for all tuition. They may not accept employment during the term of their appointment, nor are they required to render any service to the University. In some cases a fellow will be expected to limit his research to a broad field specified by the donor. Fellows are required to pay specific charges, such as admission, late registration, change of schedule, thesis binding, microfilming, and parking fees.

**GRADUATE SCHOOL FELLOWSHIPS**—Eleven fellowships, each paying a stipend of \$2,000 for the fall, winter, and spring terms, and providing a grant-in-aid to cover all tuition charges for these terms, are given by the University and are designated as Graduate School Fellowships. They are available to outstanding advanced graduate students in any field, although preference is given to applicants majoring in the humanities and social sciences. An applicant must have completed at least one full year of graduate study prior to beginning the fellowship tenure and be a candidate for the doctoral degree.

Applications should be addressed to the Dean of the Graduate School and must be received by March 1 to be considered for the following fall, winter, and spring.

**FELLOWSHIPS FROM FOUNDATIONS AND INDUSTRIES**—At least 90 such fellowships, with various stipends, are awarded through the individual departments. Information and application forms may be secured from the head of the major department concerned. The fellowships which are awarded will vary somewhat from year to year, but the following are typical of those which were available for 1961-62:

**AMERICAN CHEMICAL SOCIETY (PETROLEUM RESEARCH FUND)**—Open to graduate students in chemistry and chemical engineering; stipend \$2,000-\$2,400.

**AMERICAN CHEMICAL SOCIETY (PETROLEUM RESEARCH FUND)**—Open to graduate students in fuel technology; stipend \$2,280.

**AMERICAN CHEMICAL SOCIETY (PETROLEUM RESEARCH FUND) (2)**—Open to graduate students in geochemistry, mineralogy, and solid state technology; stipend \$2,400.

**AMERICAN CHEMICAL SOCIETY (PETROLEUM RESEARCH FUND)**—Open to graduate students in geology; stipend \$2,400.

**AMERICAN CYANAMID FELLOWSHIP IN CHEMISTRY AND CHEMICAL ENGINEERING**—Open to a graduate student for the final year of study leading to the Ph.D. degree. Awarded in alternate years to a chemist and to a chemical engineer; stipend \$1,800.

**AMERICAN IRON AND STEEL INSTITUTE (2)**—Open to graduate students in geochemistry and metallurgy; stipend \$2,400.

**AMERICAN PETROLEUM INSTITUTE FELLOWSHIPS (5)**—Open to graduate students in chemistry and physics for research concerning the synthesis and properties of high molecular weight hydrocarbons; stipend \$1,710-\$2,280.

**AMERICAN PETROLEUM INSTITUTE FELLOWSHIPS (2)**—Open to graduate students in geochemistry, ceramic technology, mineralogy, and solid state technology for research concerning the synthesis and properties of clays and related inorganic phases; stipend \$2,280-\$2,400.

**AMERICAN PETROLEUM INSTITUTE DRILLING RESEARCH FELLOWSHIP**—Open to graduate students in mining or petroleum and natural gas engineering for studies related to drilling and rock penetration; stipend \$2,400.



## FELLOWSHIPS

AMERICAN ZINC INSTITUTE FELLOWSHIP—In support of graduate research involving zinc or its compounds. Open to students in solid state technology, geochemistry, or allied fields; stipend \$2,400.

AMERICAN ZINC INSTITUTE FELLOWSHIPS (2)—Open to students in ceramic technology; stipend \$2,000.

ARMSTRONG SUMMER FELLOWSHIPS IN CHEMISTRY (6)—Open to graduate students in chemistry; stipend \$534.

BASIC, INC., FELLOWSHIP—Open to graduate students in ceramic technology; stipend \$2,400.

CARBORUNDUM CORPORATION FELLOWSHIP—Available to a graduate student in mineral preparation; stipend \$2,400.

CONTINENTAL OIL COMPANY FELLOWSHIP—Available to graduate students in petroleum and natural gas engineering for studies in petroleum engineering; stipend \$2,280.

CORNING GLASS WORKS FOUNDATION FELLOWSHIP—In support of graduate work on glass or any of its components; stipend \$2,400.

CURTISS-WRIGHT FELLOWSHIP—Open to graduate students in engineering; stipend \$1,800.

EASTMAN KODAK FELLOWSHIP IN ENGINEERING—Open to graduate students in the College of Engineering and Architecture; stipend \$1,800.

ESSO RESEARCH AND ENGINEERING POSTGRADUATE FELLOWSHIP IN CHEMISTRY AND CHEMICAL ENGINEERING—Open to advanced graduate students for one year of study leading to the Ph.D. degree; stipend \$2,400.

ETHYL CORPORATION FELLOWSHIP—Open to graduate students in chemistry; stipend \$2,000.

W. S. ELLIOTT FELLOWSHIP—Available to a graduate student who is a Penn State graduate and is interested in engineering research; stipend \$1,200.

GENERAL ATOMIC DIVISION OF GENERAL DYNAMICS CORPORATION FELLOWSHIP—Open to graduate students in physics; stipend \$2,500.

GENERAL ELECTRIC FELLOWSHIP—Open to graduate students in ceramic technology; stipend \$1,750-\$2,500.

GENERAL FOODS FUND FELLOWSHIPS (2)—For graduate work with a major in home economics; stipend \$3,000.

GULF OIL COMPANY FELLOWSHIP IN PETROLEUM AND NATURAL GAS ENGINEERING—For graduate work in petroleum production; stipend \$2,400.

HAMILTON STANDARD FELLOWSHIP—Open to graduates of this University in aeronautical, electrical, and mechanical engineering, engineering mechanics, and physics; stipend \$1,800.

INTERNATIONAL BUSINESS MACHINES CORPORATION FELLOWSHIP—Open to an outstanding graduate student doing research in physical science or engineering; fellowship rotated annually among certain departments specified by the company; stipend \$1,800-\$2,500.

KAISER ALUMINUM AND CHEMICAL CORPORATION FELLOWSHIP—Open to students in ceramic technology for studies in ceramic technology; stipend \$2,004.

KOPPER'S SUMMER SUPPLEMENTAL TEACHING FELLOWSHIPS (2)—Open to graduate students in chemistry; stipend \$600.

LEAD INDUSTRIES ASSOCIATION FELLOWSHIP—Open to graduate students in ceramic technology for studies of lead oxide systems; stipend \$1,992.

LEAD INDUSTRIES ASSOCIATION FELLOWSHIP—Open to graduate students in geochemistry, mineralogy, and solid state technology; stipend \$2,400.

MOLYBDENUM CORPORATION OF AMERICA—Open to a graduate student in mineral preparation; stipend \$2,400.

MONSANTO SUMMER RESEARCH FELLOWSHIPS (2)—Open to graduate students in chemistry; stipend \$650.

NATIONAL SCIENCE FOUNDATION CO-OPERATIVE GRADUATE FELLOWSHIPS—The Graduate School participates in this program of fellowships available in the biological,

engineering, mathematical, and physical sciences, anthropology, economics (excluding business administration), geography, history and philosophy of science, psychology (excluding clinical), and sociology (excluding social work). Also included are interdisciplinary fields such as biophysics, geochemistry, and meteorology. Applications for the following year must reach the Dean of the Graduate School by November 1.

**OHIO OIL COMPANY FELLOWSHIP IN PETROLEUM AND NATURAL GAS ENGINEERING**—Open to graduate students in petroleum engineering; stipend \$2,000.

**EDWARD ORTON, JR., CERAMIC FOUNDATION FELLOWSHIP**—Open to students in ceramic technology for studies relating to kiln-fired ceramic bodies; stipend \$1,800.

**OWENS-CORNING FIBERGLAS FELLOWSHIP IN INORGANIC CHEMISTRY**—Open to a graduate student in inorganic chemistry for the final year of study leading to the Ph.D. degree; stipend \$2,400.

**OWENS-CORNING FIBERGLAS FELLOWSHIP IN CERAMIC TECHNOLOGY**—Open to graduate students in ceramic technology; stipend \$3,000.

**PENNSYLVANIA CO-OPERATIVE WILDLIFE ASSOCIATION (2)**—Available to graduate students in forestry; stipend \$1,872-\$2,024.

**PENNSYLVANIA NATURAL GAS MEN'S FELLOWSHIP**—For graduate work in petroleum and natural gas engineering for studies in gas technology; stipend \$2,000.

**PENNSYLVANIA POWER AND LIGHT COMPANY FELLOWSHIP**—Open to graduate students in mineral preparation; stipend \$2,400.

**PFAUDLER-PERMUTIT FELLOWSHIP**—Open to students in ceramic technology; stipend \$3,000.

**PITTSBURGH PLATE GLASS FELLOWSHIP**—Open to graduate students in ceramic technology for fundamental studies of glass; stipend \$3,000.

**RADIO CORPORATION OF AMERICA FELLOWSHIP**—Open to graduate students in electrical engineering; stipend \$2,520.

**SHELL FELLOWSHIP IN CHEMICAL ENGINEERING**—Open to graduate students in chemical engineering for the final year of study leading to the Ph.D. degree; stipend \$2,400.

**SHELL SUMMER FELLOWSHIPS IN CHEMISTRY (4)**—Open to graduate students in chemistry; stipend \$750.

**SOCONY-MOBIL OIL FELLOWSHIP**—Available for graduate students in chemical engineering; stipend \$2,000.

**SPEER CARBON FELLOWSHIP**—Open to graduate students in fuel technology for studies on carbon; stipend \$2,400.

**STACKPOLE FERRITE FELLOWSHIP**—Open to students in ceramic technology; stipend \$3,000.

**STACKPOLE FELLOWSHIP IN METALLURGY**—Open to graduate students in metallurgy for studies in powder metallurgy; stipend \$2,280.

**SPRAGUE ELECTRIC COMPANY FELLOWSHIP**—Open to students in ceramic technology; stipend \$2,400.

**STAUFFER CHEMICAL COMPANY FELLOWSHIP IN CHEMISTRY**—Open to a graduate student in chemistry for research on organometallic compounds; stipend \$1,800.

**SUN OIL COMPANY FELLOWSHIP IN CHEMISTRY**—Open to advanced graduate students in chemistry for study leading to the Ph.D. degree; stipend \$1,800.

**TEXACO, INC., FELLOWSHIP**—Open to a graduate student in physics; stipend \$3,000.

**UNION CARBIDE METALS FELLOWSHIP**—Open to graduate students in metallurgy; stipend \$2,280.

**U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE: OFFICE OF VOCATIONAL REHABILITATION TRAINEESHIPS IN VOCATIONAL REHABILITATION COUNSELING (36)**—Open to graduate students in the Department of Educational Services who are specializing in vocational rehabilitation counseling; stipend \$1,800-\$2,000.

**U. S. PUBLIC HEALTH SERVICE TRAINEESHIPS IN CLINICAL PSYCHOLOGY (7) AND IN SCHOOL PSYCHOLOGY (3)**—Open to selected graduate students in these areas of psychology; stipend \$1,800-\$3,000.

**U. S. PUBLIC HEALTH SERVICE TRAINEESHIPS IN PUBLIC HEALTH NUTRITION**—Open to selected graduate students in foods and nutrition; stipend \$3,000.



## OTHER AIDS

**UNITED STATES STEEL FOUNDATION FELLOWSHIP**—Open to graduate students in the College of Mineral Industries for studies related to steel-making; stipend \$2,880.

**VETERANS ADMINISTRATION INTERNSHIPS IN CLINICAL PSYCHOLOGY (18)**—Open to selected advanced graduate students in this area of psychology.

In addition, numerous grants are available from governmental agencies, industrial concerns, and foundations for the support of investigations of particular problems. Many of these permit full-time study and carry the same exemptions as the fellowships listed above. Detailed information may be secured from departments.

**EXTERNALLY ADMINISTERED FELLOWSHIPS**—Attention is directed to the following fellowships which are awarded nationally and may be used at the university of the recipient's choice:

**NATIONAL INSTITUTES OF HEALTH FELLOWSHIPS**—Available to graduate students in the basic sciences, such as biology, chemistry, zoology, physiology, biochemistry, etc., as they relate to problems of health and disease; and among the social sciences, those areas, such as psychology and sociology, which relate to the problems of health and disease and some interdisciplinary fields such as biostatistics, medical economics, cultural anthropology, etc. These fellowships are used at the university of one's choice, and application should be made to the Career Development Review Branch, Division of Research Grants, National Institutes of Health, Bethesda, Maryland.

**NATIONAL SCIENCE FOUNDATION GRADUATE FELLOWSHIPS**—These fellowships, which are somewhat different from the NSF Co-operative Fellowships mentioned above, are also awarded for graduate study in the biological, engineering, mathematical, and physical sciences, anthropology, economics (excluding business administration), geography, history and philosophy of science, psychology (excluding clinical), and sociology (excluding social work). Also included are interdisciplinary fields such as biophysics, geochemistry, and meteorology. These fellowships are used at the university of one's choice. Application is made during the fall to the National Science Foundation, Washington 25, D. C. The application deadline is usually about January 1.

**WOODROW WILSON NATIONAL FELLOWSHIPS**—Awarded by the Woodrow Wilson National Fellowship Foundation for first year graduate study at the institution of one's choice, to outstanding students who show a clear preference for a career in college teaching, especially in the areas of the humanities and social sciences. In exceptional cases consideration will be given to students in the natural sciences.

A student must be nominated by a professor in his undergraduate college, the nomination being sent to the regional chairman of the Woodrow Wilson Fellowships for the area in which that college is located. Applicants should consult the dean or other official of their college or write to the Woodrow Wilson National Fellowship Foundation, Box 642, Princeton, N. J. Nominations must reach the regional chairman by October 31.

## OTHER AIDS

**COUNSELORSHIPS FOR MEN**—A number of appointments are available to men graduate students to serve as Resident Counselors in the undergraduate residence halls for men. A counselor's responsibility is to work for the social, academic, and emotional adjustment of the undergraduate residents. Specialized training in personnel work is desirable, though not essential.

These appointments are for three terms (fall, winter, and spring) and provide the recipient with room and board and a grant-in-aid for full tuition. A more limited number of appointments are available during the summer term. A counselor may not hold a fellowship, or additional assistantship, during the term of his appointment as a counselor. He may not engage in any other form of part-time employment. He may carry 7-9 credits per term.



Requests for information and application forms should be addressed to the Dean of Men.

**SENIOR RESIDENT POSITIONS FOR WOMEN**—Full-time salaried appointments as Senior Residents in undergraduate halls for women are available to qualified women graduate students. Responsibilities include working with student groups in a programming capacity, counseling, and supervising the residence hall during the evening.

These positions permit the holders to take 4 graduate credits per term at \$5.50 per credit. Appointments are made for the fall, winter, and spring terms. Special arrangements of hours of work and credits may be made for the summer term. It is thus possible to complete work for a master's degree in nine terms.

Requests for information and application forms should be addressed to the Dean of Women.

**GRADUATE GRANTS-IN-AID**—Forty grants for full-time study are awarded each year on a term basis, providing for all tuition. They are available to any student on the basis of financial need and academic promise. A recipient is expected to carry a full program of graduate work but may accept employment with the University or another employer not to exceed 10 hours per week, provided he reduces his academic load to 8 or 9 credits. Application for renewal of the grant-in-aid may be made for succeeding terms. The value of these grants to Pennsylvanians is \$175 per term, to non-Pennsylvanians, \$350 per term.

Applications should be addressed to the Dean of the Graduate School and must be received by March 1 to be considered for the following summer or fall.

**DU PONT TEACHING AWARD IN CHEMISTRY**—To be eligible for the E. I. du Pont de Nemours and Company Postgraduate Teaching Assistant Award, a graduate student must be currently serving as a part-time teaching assistant and preferably should have had two years of experience in this capacity. The recipient receives \$1200 in addition to the regular stipend paid him as a teaching assistant.

**JOHN W. WHITE FELLOWSHIP**—Awarded to two graduates of The Pennsylvania State University each year on the basis of scholarship, need, character, and attitude. The recipients may enroll in any approved college or university.

**SCHOLARSHIPS**—A number of scholarships furnished by outside agencies and organizations are awarded annually through individual departments. A request for information should be directed to the department head in the field of the student's major interest.

**A.A.U.W. SCHOLARSHIP**—The State College Chapter of the American Association of University Women has established a modest scholarship which is awarded annually to honor an outstanding woman graduate student. The award does not include exemption from tuition. Nominations are made by departments.

**GENERAL LOAN FUNDS**—Such funds are available from two sources: (1) University loan funds, in limited amounts; (2) loan funds received by the University under Title II of the National Defense Education Act of 1958. Graduate students who are classified as full-time students by the Dean of the Graduate School are eligible for a loan. Information and application forms may be obtained from the director of the Office of Student Aid, 218 Willard Building.

**ASSURED EDUCATION PLAN**—The University offers to the parents (or guardians) of students the Assured Education Plan, enabling them to pay University bills out of current income on a monthly basis. It is available to parents residing anywhere in the United States. There are two plans, one covering a single year's expenses, the

## STUDENT SERVICES

other covering two to five years' expenses in a single contract. Life insurance and total and permanent disability insurance are a part of the plan for a parent up to his 68th and 61st birthdays respectively.

In the one-year plan repayment may be made in 8, 10, or 12 monthly payments, the credit service charge being  $2\frac{2}{3}$  per cent,  $3\frac{1}{2}$  per cent, or 4 per cent respectively. The charge for the insurance is 62 cents a month for each \$1,000.

Under certain conditions graduate students may sign their own agreements under the one-year plan only. The student, or spouse, if any, must be at least 21 years of age, employed, and furnish credit information. If married, the spouse must sign the agreement with the student. Repayment must be made in one year, except for terminal year students, who may have 24 months for repayment. Further information and application forms may be obtained from the Office of the Bursar.

**GRADUATE SCHOOL EMERGENCY LOAN FUND**—This fund has been established through the efforts of the University Alumni Fund and contributions of Graduate School alumni who have received their bachelor's degrees elsewhere. The Graduate Student Association recently made a sizable contribution to it. The purpose of this fund is to assist graduate students on a short-term loan basis in meeting somewhat unexpected financial obligations associated with receiving a degree, such as thesis typing, thesis binding and microfilming fee, job interview travel, etc.

Loans may not exceed \$200. The fund is administered by the Dean of the Graduate School, and application forms may be obtained at his office.

**STUDENT EMPLOYMENT**—Many students depend upon part-time employment to help meet their expenses. A student who is thus employed, however, must recognize the time demands of his work schedule and will be required to adjust his academic load accordingly.

A student who holds a graduate assistantship or a fellowship may not accept employment, either at the University or elsewhere, during the period of his appointment.

The Office of Student Aid, 218 Willard Building, offers assistance to students in finding part-time employment in town as well as on the campus.

**VETERANS BENEFITS**—The Co-ordinator of Veterans Affairs has the responsibility of handling all applications for benefits under the various Public Laws.

Under Public Law 550, a student is classified as to his rate of training on the basis of the type of program he is following and the number of credits for which he registers.

## STUDENT SERVICES

**HEALTH CENTER**—The services of the Ritenour Health Center are available to graduate students registered for 8 or more credits and to all graduate assistants, fellows, and other holders of graduate tuition grants.

Students are entitled to five days' free treatment in the University Hospital each term. For each day of confinement in excess of five days a charge of \$10 will be made. Almost all modern drugs are furnished free of charge as required for treatment, but the student may be charged extra for medication where such treatment is unusual or extremely expensive. Consult the *Manual for Graduate Students* for details concerning facilities and services.

**INSURANCE PLAN**—A voluntary Accident and Sickness Insurance Plan with a variety of benefits is available to graduate students and their families. The Student Government Association, which operates the plan, has offices in the HUB.



**PLACEMENT SERVICE**—The University Placement Service co-ordinates the placement activities of all the Colleges and the Graduate School. It is available to any student who is in need of counseling or guidance on employment problems. The services of the following sections are available to the student without charge.

The General Placement Section functions primarily as a clearing house, bringing together students, alumni, faculty members, and representatives of organizations that are seeking college-trained personnel. Summer jobs other than those at camps or resorts are listed at this office.

The Teacher Placement Section assist seniors, alumni, and graduate students in all departments in securing teaching positions.

**RELIGIOUS PROGRAMS**—The University seeks to serve the spiritual needs of its students and staff. General responsibility for religious activity on the campus rests with the University Chaplain and Co-ordinator of Religious Affairs. Individual organizations under the sponsorship of members of the Jewish, Protestant, and Roman Catholic faiths serve the student body. Many other religious organizations, including denominational and interdenominational groups, are active on the campus and in association with local churches.

**STUDENT AFFAIRS**—The Graduate Student Association is the official University-wide organization of graduate students. All students have membership in the Association, which promotes the general welfare and the academic interests of graduate students. It publishes the *Graduate School Newsletter*, helps to sponsor the Graduate School lecture series, and sponsors social functions.

## MASTERS' DEGREES

The Graduate School recognizes a difference in purpose, which is reflected in the requirements, for two types of advanced degrees: academic and professional. Of the eight masters' degrees conferred, the Master of Arts and the Master of Science are academic in nature. The professional degrees conferred are Master of Agriculture, Master of Business Administration, Master of Education, Master of Engineering, Master of Forestry, and Master of Public Administration.

The student should understand that a well-balanced, unified, and complete program of study will be required regardless of the minimum credit requirement. A degree is not conferred for a mere collection of credits. Many students find it necessary to earn more than the minimum number of credits before they are regarded as being ready for the degree. In order to avoid possible disappointment, the student should not think of the master's degree as a "one-year degree." The University is not committed to granting a degree upon completion of 30 credits.

The student may meet the degree requirements as either a full-time or a part-time student and by attendance during any combination of terms.

**ADMISSION**—Adequate undergraduate preparation is required in the field in which the applicant expects to pursue advanced work. The specific courses and the total number of undergraduate credits required in various areas will be determined by the choice of field and can be ascertained from the descriptive statement appearing under the major field heading in the latter portion of this bulletin. An applicant who meets the minimum grade point average but is deficient in course preparation may, under certain circumstances, be admitted to the Graduate School and allowed to make up the undergraduate deficiencies. Under these circumstances the program will require more than the minimum period of residence. An applicant for admission to the M.Ed. program is required to have had at least 18 credits in education and related psychology, and in certain major fields may be required to have had practice teaching.

After a student has been admitted as a regular graduate student, he should confer with the head of his major department concerning the appointment of an adviser.



## MASTERS' DEGREES

The general guidance of a master's candidate is the responsibility of an adviser, or of a committee appointed in a manner to be determined by the major department in which the student is specializing. The adviser or the committee assists the student in planning a program of study. Although the adviser is frequently the supervisor of the thesis, this is not necessarily the case.

Requirements concerning courses, language proficiency, minors, comprehensive examinations, and other matters are sometimes made by departments in addition to (but not in conflict with) the regulations of the Graduate School. For details the student should consult the head of the major department.

**TIME LIMITATION**—All requirements for a master's degree, whether satisfied here or elsewhere, must be met within six years, or a period spanning seven consecutive summers.

### M.A. AND M.S.—SPECIFIC REQUIREMENTS

The Master of Arts and the Master of Science degrees have similar requirements, the general major area determining which degree is conferred.

A minimum of 30 graduate credits is required of which at least 20 must be earned on the University Park Campus. A candidate must present a major and either a minor field of study or an approved group of general studies. A minor consists of no fewer than 6 credits of integrated or articulated work in one field related to but different from that of the major. A general studies group consists of no fewer than 6 credits in fields other than that designated as the major field and considered by the major department to have significance and value for the candidate.

At least 18 credits in graduate courses (500 series) and thesis research (600 or 610) combined must be included in the program. A minimum of 12 credits in course work, as contrasted with research, must be completed in the major field and at least 6 credits must be devoted to a thesis.

The thesis is prepared under the direction of the department in which the candidate's major work is taken. Under certain conditions a student may complete the thesis off-campus. To do so he must make satisfactory arrangements in advance with both the major department and the Dean of the Graduate School.

A *Thesis Information Bulletin*, which gives details concerning format, paper, illustrations, and other items, may be obtained at the Graduate School office.

### M.AGR.—SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Agriculture has a professional orientation and provides training for increased competence in the various fields of agriculture. It should be clearly distinguished from the research-oriented program which leads to the academic degree of Master of Science.

A minimum of 30 graduate credits is required of which at least 20 must be earned on the University Park Campus.

A candidate is required to earn at least 12 credits in graduate courses (500 level) and a minimum of 12 credits outside his major field.

In addition to credit requirements, a candidate must present a paper on a selected professional problem comparable in quality to a thesis in which he applies scientific methods to the solution of a problem. Ability must be demonstrated to (a) formulate and state meaningfully the problem and objectives, (b) critically analyze the present state of knowledge of the problem, (c) acquire and analyze information to help solve the problem, (d) draw logical conclusions, and (e) interpret the relationship between the findings and professional problems. The paper will be evaluated by a committee appointed by the Dean of the Graduate School.

The candidate is required to pass a final examination administered by a committee of three faculty members appointed by the Dean of the Graduate School with at least one member from a department other than that of the candidate's major field.

### M.B.A.—SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Business Administration is designed to develop advanced professional competence in the various fields of business administration. It should be distinguished carefully from the research-oriented programs which lead to the academic degrees of Master of Science and Doctor of Philosophy with a major in Business Administration.

The program requires a minimum of 36 graduate credits of which at least 18 must be at the 500 level and at least 26 must be earned on the University Park Campus. Candidates who enter this program without undergraduate training in business administration may be required to take up to 21 credits of preparatory courses.

Moreover, a candidate is required to present a project paper, comparable in quality and scope of work to a graduate thesis, concerning a problem of a company.

After substantially completing his course requirements, a candidate must pass a comprehensive examination to be administered by a committee composed of graduate faculty members, the first part being written and the second part oral. During these examinations the candidate will be expected to demonstrate his ability to integrate the knowledge gained in the several functional areas of business in a manner which reflects a broad knowledge of his professional responsibilities.

Applicants for the various graduate programs in business administration are required to take the admission test for graduate study in business given by the Educational Testing Service.

### M.Ed.—SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Education provides preparation for increased professional competence in the several fields of education. It should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Arts or Master of Science.

A minimum of 30 graduate credits is required of which at least 20 must be earned on the University Park Campus and at least 24 must be in course work.

At least 15 credits in 500 series courses is required except in those fields for which the Dean has approved the waiving of this requirement for an experimental period of five years.

**MAJORS IN THE FIELDS OF EDUCATION**—A student may major in one of the approved fields of education, such as elementary education, art education, or home economics education, and proceed under the guidance of the appropriate department of education.

A program of this type requires at least 6 credits to be earned outside the fields of education.

Each candidate takes a diagnostic examination, administered by the Department of Educational Services, which serves as a guide in outlining a program of study to fit his individual needs.

**MAJORS OUTSIDE THE FIELDS OF EDUCATION**—A student who is preparing to teach in a specific subject-matter field, such as chemistry, mathematics, or German, may choose such a field as his major and take the majority of his work in it under the guidance of the department offering that major. A student wishing to work in a broader area may choose such a major as biological science, earth sciences, phys-



## MASTERS' DEGREES

ical science, or social studies and take at least 24 credits in the area under the guidance of the committee in charge of the major. In this case the student will be expected to choose one field in the area as a primary interest and devote at least 12 credits to it.

Each candidate is required to earn 6 credits in education and to take the examination in educational foundations which is administered by the Department of Educational Services. If adequate background is demonstrated, the candidate may then offer 6 credits in any field of education. If adequate background is not demonstrated, the 6 credits must be in educational foundations, which includes the following specific courses in comparative education, educational measurements and statistics, educational psychology, history of education, and philosophy of education: Ed.Ser. 417, 418, 490, 494, 516, 517, 522, 590; and Psy. 414, 502, 513, 514.

**THESIS OR TERM PAPER**—Six credits may be granted for an approved thesis. Those candidates who do not elect to write a thesis are required to present an essay or term paper. It must be of considerable proportion, indicating capacity to describe a serious intellectual experience adequately in writing, and giving unmistakable evidence of ability to formulate and state meaningfully the purpose of an investigation, study, critical analysis, or evaluation; to acquire and analyze information; to draw conclusions logically; and to relate findings to professional problems and practices. The nature and extent of such a piece of writing, whether it be required in connection with a course or independently of course work, and when it is to be undertaken shall be determined by the major department. The department shall report to the Dean of the Graduate School the title, the name of the faculty member under whom the student did the work, and whether the work was considered adequate. It is the right, but not the responsibility, of the department to require one or more copies of such an essay for its library or other files.

### M.ENG.—SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Engineering provides training for advanced professional competence in the several fields of engineering. It should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Science.

A minimum of 30 graduate credits is required of which at least 12 must be earned in graduate courses (500 series), and at least 6 must be earned outside the candidate's field of concentration.

A scholarly written report on a developmental study involving at least one area represented in the candidate's course work is required as an integral part of the program. The report must be comparable in its level of work and quality to a graduate thesis.

No work for this degree is required to be done specifically on the University Park Campus provided the major department or supervisory committee agrees that a suitable program can be pursued elsewhere.

### M.F.—SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Forestry provides training for increased professional competence in the several specialized areas of forestry and wood utilization. It should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Science with a major in forestry.

A minimum of 30 graduate credits is required of which at least 20 must be earned on the University Park Campus.



## DOCTORAL DEGREES

A candidate for the degree of Master of Forestry should choose one area for his major and one or two related areas for his minor. The proportion of credits to be taken in the major and minor fields of study will be determined in consultation with the student's advisory committee. It is expected that the larger part of the program shall be in graduate courses (500 series), but no specific number of credits in the 500 series is required.

Each candidate is required to prepare and submit an acceptable thesis. At least 6 credits of thesis work is required.

### M.P.A.—SPECIFIC REQUIREMENTS

The M.P.A. is a professional degree for students who are planning careers in public administration at local, state, national, and international levels or with private and voluntary agencies. This program should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Arts with a major in political science in which the candidate may also specialize in public administration.

For the M.P.A. degree a minimum of 36 graduate credits is required of which at least 6 must be devoted to either a thesis or internship. Students with extensive government experience will write a thesis; others will serve an internship and write a critical review of the experience, the review to be comparable in quality to a thesis. A comprehensive final examination will be required of all students, the examination to be written, oral, or both.

No work for this degree is required to be done specifically on the University Park Campus provided the major department or supervising committee approves its being done elsewhere.

The degree is a terminal one and credits earned in the program may or may not be applicable, even in part, toward a doctorate.

## DOCTORAL DEGREES

The Doctor of Philosophy, an academic degree, and the Doctor of Education, a professional degree, are conferred. The two programs are recognized as different in purpose and consequently have different requirements in certain respects.

**ADMISSION**—A student who has been admitted to the Graduate School and has been accepted by the department or committee in charge of a major field in which the doctorate is offered may begin working toward a doctor's degree. However, he has no official status as a doctoral student and no assurance that he will be accepted as a doctoral candidate until he has passed a candidacy examination. This examination is administered by the major department and is given near the end of the first, or at the beginning of the second, year of graduate work including that done for the master's degree and work done elsewhere as well as here (i.e., at about the time he has earned a total of 30 graduate credits).

A new student transferring from another graduate school with 30 or more transfer credits must take this examination before he has earned more than 10 credits here.

**GENERAL REQUIREMENTS**—No specified number of courses completed or credits earned will assure the attainment of the doctorate. The general requirements are based upon a period of residence, the passing of comprehensive examinations, and the writing of a satisfactory thesis. A doctoral program consists of such a combination of courses, seminars, and individual study and research as meets the minimum requirements of the Graduate School and is approved by the doctoral

## DOCTORAL DEGREES

committee for each individual student. It includes work in a major field of study and in either a minor field or a group of general studies.

A master's degree is not a prerequisite for the doctorate. However, the first year of graduate study leading to the Ph.D. may be substantially the same as that provided for the M.A. or M.S. degree. Similarly the first year of the D.Ed. program may be essentially the same as that provided for the M.Ed.

**RESIDENCE REQUIREMENTS**—A minimum of nine terms of full-time graduate study and research, or their equivalent in credits, is required for a doctor's degree. At least 30 credits must be earned in residence at the University Park Campus.

For a period of three terms, two of which must be consecutive, the Ph.D. candidate must limit his work load to half-time at most, the balance of his time being devoted to graduate study. The D.Ed. candidate may meet the residence requirement by enrollment in the summer terms, but increasingly departments are insisting upon the same requirements as for the Ph.D.

A graduate assistant or research assistant who is a candidate for the doctorate, has passed the comprehensive examination, is registered for the maximum allowable credit load, and is certified by his department as devoting all his time to studies and thesis research to meet his degree requirements may be regarded by the Dean of the Graduate School as a full-time student for a period not exceeding one calendar year. Such a student will be considered to earn the equivalent of 10 credits per term and three such terms will meet the minimum residence requirement for the Ph.D.

**OFF-CAMPUS AND TRANSFER CREDITS**—A maximum of two full academic years of residence work (60 credits) in another approved school granting the doctorate in the major field may be accepted by the Graduate School in partial fulfillment of the requirements for a doctoral degree at The Pennsylvania State University. Not more than one year of residence (30 credits) at a graduate school not granting the doctorate in the major field will be accepted here to apply toward doctoral degree requirements. Credit for courses and research work done elsewhere can be used to meet degree requirements, however, only if the work is appropriate to the candidate's proposed program of study as determined by his doctoral committee.

By securing the maximum allowable number of transfer credits, it is possible theoretically to complete the requirements at this institution in three terms. In practice, however, this is rarely possible because of the sequence required in courses and examinations, special departmental requirements, and the possibility of protracted research. It must be remembered that the quality of the program rather than the time requirement is of paramount concern.

Subject to the approval of his adviser, the head of his major department, and the Dean of the Graduate School, a student may register for research to be done away from the University Park Campus. Such work will not be approved, however, simply because the arrangement is convenient for the student; scholarly considerations must determine the choice of location. A doctoral candidate may register for a maximum of 30 credits of research *in absentia*, but these credits must be included in the 60 credits which a candidate may earn in study away from the University Park Campus. The maximum load permitted a student who is employed full time is 4 credits in a term.

A candidate for a doctor's degree may apply toward the minimum requirements a maximum of 10 credits earned in approved classes in Continuing Education or at the Commonwealth Campuses of The Pennsylvania State University.

**ADVISERS AND DOCTORAL COMMITTEES**—After a student has been admitted as a regular graduate student, he should confer with the head of his major department concerning departmental procedures and the appointment of an adviser. The arrangement and approval of the details of the term-by-term schedule of the student is the function of the adviser. This person may be a member of the doctoral



committee or someone else designated by the head of the major department for this specific duty.

The general guidance of a doctoral candidate is the responsibility of a doctoral committee consisting of five or more members of the Graduate Faculty. The committee is appointed by the Dean of the Graduate School, upon recommendation of the head of the major department, at the time the student is admitted to candidacy. The chairman of the committee must hold senior membership in the Graduate Faculty. The supervisor of the candidate's thesis will usually, but not necessarily, be designated as chairman. At his discretion, the Dean may add other members to the committee.

The doctoral committee is responsible for establishing the broad outline of the student's program and should review the program as soon as possible after admission to candidacy. The committee will prepare, give, and evaluate the candidate's examinations, and supervise and approve his thesis. A favorable vote of at least two thirds of the members of the committee is required for passing a comprehensive or a final examination. If a candidate fails an examination, it is the responsibility of the doctoral committee to determine whether he may take another examination.

The committee will also notify the Dean when the candidate is ready to have his comprehensive and his final examination scheduled and will report the results of these examinations to the Dean.

**LANGUAGE EXAMINATIONS**—A candidate for the degree of Doctor of Philosophy is required to demonstrate high-level competence in the use of the English language, including reading, writing, listening, and speaking. Proficiency is expected at the time of admission to the Graduate School and must be achieved before admission to candidacy.

In addition to demonstrating competence in English, each candidate for the Ph.D. must show either a reading knowledge of two other languages or a reading, writing, listening, and speaking knowledge of one other language. The languages used to satisfy this requirement must have significance in the candidate's field of study and be approved by the candidate's doctoral committee and the Dean of the Graduate School. French, German, and Russian are the languages most frequently needed and will be approved by the Dean without specific request. The use of any other language must be approved in advance.

When competence in two languages is offered in fulfillment of the requirements, the student is urged to complete one-half of the requirement before admission to candidacy and is required to complete the whole requirement before taking the comprehensive examination. If the candidate elects to demonstrate a reading, writing, listening, and speaking knowledge of one language, he is required to demonstrate competence in two of the four skills before admission to candidacy and in all four before taking the comprehensive examination.

Registration for both types of examination occurs at the beginning of the term, the specific date being given in the calendar. An applicant for an examination in reading competence is required to present himself to the language department concerned for a preliminary test in oral translation, not to exceed 15 minutes' duration during the registration period of one of the terms. A student who makes a very poor showing in the preliminary test will not be permitted to register for the next examination and may be required to take another preliminary test.

The examinations in reading competence are administered by the respective language departments and are held four times each year. Specific dates may be obtained from the calendar. The examination, which is to be written and to be completed with the aid of a dictionary, is one hour in length. The text for translation shall be a periodical article selected by the examining department from five articles in the candidate's field of specialty and recommended by his adviser or department head. Each of the articles recommended shall be not less than 500 words in length.



## DOCTORAL DEGREES

Administration of the examinations designed for demonstration of a reading, writing, listening, and speaking knowledge of a language other than English is vested in two members of each of the foreign language departments. Immediately upon registration the candidate is assigned by the examiners a work of considerable length unrelated to the area of his specialty; discussion of this work with the examiner six weeks later in the language in which it is written will serve to determine the candidate's broad, idiomatic grasp of the language. Subsequently, the candidate will be required without prior preparation to write in the same language a summary of the contents of a shorter document in the area of his specialty. For this purpose his adviser or department head is expected to recommend to the examiners five articles of at least 500 words in length, the titles of which are not known to the student, from which they will select the one to be employed. All arrangements for the examination are to be made in the language in which competence is to be demonstrated.

Certificates of proficiency must be obtained if language requirements have been met at another institution prior to admission to the Graduate School at Penn State. In this case it is the general policy to require a letter from the Graduate Dean of the institution in which the foreign language examination was taken, stating that the examination taken by the student was that required of prospective Ph.D. candidates. Other evidence, such as examinations here, may also be required.

Candidates for the D.Ed. degree may be required by their major departments to demonstrate competency in foreign languages, but there is no Graduate School requirement.

**COMPREHENSIVE EXAMINATIONS**—A candidate for the Ph.D. or D.Ed. degree is required to take a comprehensive examination covering his major and minor fields to determine if he has adequate mastery of the subject matter to entitle him to proceed to the completion of a thesis.

This examination will normally be taken when the candidate has substantially completed his course work. It is officially scheduled and announced by the Dean of the Graduate School upon recommendation of the doctoral committee. In no case may the final examination be scheduled less than three months after the comprehensive examination. The comprehensive examination is given and evaluated by the doctoral committee and may be either written or oral, or both. A favorable vote of at least two thirds of the members of the committee is required for passing. In case of failure, it is the responsibility of the doctoral committee to determine whether he may take another examination. The results are reported to the Dean of the Graduate School.

A candidate for the degree of Doctor of Philosophy must have satisfied the language requirements before taking the comprehensive examination.

**FINAL ORAL EXAMINATIONS**—The doctoral candidate who has satisfied all other requirements for the degree will be scheduled by the Dean of the Graduate School, on recommendation of the doctoral committee, to take a final examination. In no case may the final examination be scheduled less than three months after the comprehensive examination. The deadline for holding the examination is three weeks before Commencement.

The final examination is oral, open to the public, and related in large part to the thesis; but it may cover the whole field of study of the candidate without regard to courses that have been taken either here or elsewhere.

A favorable vote of at least two thirds of the members of the committee is required for passing. The results of the examination are reported to the Dean of the Graduate School and will be entered upon the candidate's official record. If a candidate fails, it is the responsibility of the doctoral committee to determine whether he may take another examination.

## PH.D.—ADDITIONAL SPECIFIC REQUIREMENTS

The degree of Doctor of Philosophy is conferred in recognition of high attainment and productive scholarship in some special field of learning as evidenced by (1) the satisfactory completion of a prescribed period of study and investigation, (2) the preparation of a thesis involving independent research, and (3) the successful passing of examinations covering both the special subject and the general field of learning of which this subject forms a part.

**MAJOR AND MINOR FIELDS**—Programs leading to the degree of Doctor of Philosophy are offered in a wide variety of fields. A program includes a major and either a minor or a group of general studies with approximately two thirds of the total time being devoted to the major field. A minor consists of no fewer than 15 credits, including those applied toward the master's degree, of integrated or articulated work in one field related to, but different from, that of the major. A general studies group consists of no fewer than 15 credits, including those applied toward the master's degree, in fields other than that designated as the major field and considered by the major department to have significance and value for the candidate.

**THESIS**—The ability to do independent research and competence in scholarly exposition must be demonstrated by the preparation of a thesis on some topic related to the major subject. It should represent a significant contribution to knowledge, be presented in a scholarly manner, reveal on the part of the candidate an ability to do independent research of high quality, and indicate considerable experience in using a variety of research techniques. The contents and conclusions of the thesis must be defended at the time of the final examination.

The completed thesis together with an abstract, typewritten in triplicate, must be filed in the office of the Dean of the Graduate School not later than two weeks prior to the commencement at which the candidate expects to receive the degree.

A *Thesis Information Bulletin*, which gives details concerning format, paper, illustrations, and other items, may be obtained at the Graduate School office.

## D.ED.—ADDITIONAL SPECIFIC REQUIREMENTS

Programs leading to the degree of Doctor of Education are not limited to specific fields of education but, with the consent of the department or committee in charge, may also be offered in any other field appropriate to the preparation of teachers which has been approved for the doctorate, such as biological science, foods and nutrition, or English.

The degree is conferred in recognition of advanced preparation of a high order for work in the profession of education as evidenced by (1) the satisfactory completion of a prescribed period of study; (2) ability to apply scientific principles in classroom instruction, supervision of instruction, administration, or as a consulting specialist in certain educational areas; (3) preparation of a thesis demonstrating ability to undertake an educational problem with originality and independent thought; and (4) successfully passing examinations showing a satisfactory grasp of the field of specialization and its relation to allied educational areas.

**MAJOR AND MINOR FIELDS**—The program of study includes a major and either a minor or a group of general studies. A majority of the courses offered in fulfillment of the requirements must be in the major field of study.

A candidate choosing a major outside the fields of education (such as speech, geography, or history) shall have a minor consisting of no fewer than 15 credits, including those applied toward the master's degree, in educational foundations, which includes the following specific courses in comparative education, educational meas-



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urements and statistics, educational psychology, history of education, and philosophy of education: Ed.Ser. 417, 418, 490, 494, 516, 517, 522, 590; and Psy. 414, 502, 513, 514.

A candidate choosing a major in one of the fields of education must also choose either a minor or a group of general studies with the approval of the major department. In this case a minor consists of no fewer than 15 credits, including those applied toward the master's degree, in one field outside the fields of education. An acceptable general studies group consists of no fewer than 15 credits, including those applied toward the master's degree, in fields outside the fields of education considered by the major department to have significance and value for the candidate.

**COMPREHENSIVE EXAMINATIONS**—In addition to demonstrating a high level of competence in the subject matter of his major and minor fields, each candidate must show in his comprehensive examination that he is familiar with current theories of education; that he understands and can apply the techniques and the findings of educational research so far as they bear upon the teaching of his subject; that he is prepared to read understandingly and contribute to the technical and professional literature in his field; and that he can criticize his own procedures in the light of historical trends and practices in this and other countries. Command of the tools for a thorough study of the problems of education is necessary and must include familiarity with statistical methods. For certain students the requirements may include a reading knowledge of one or more foreign languages.

**THESIS**—Evidence of a high degree of scholarship, competence in scholarly exposition, and ability to select, organize, and apply knowledge must be presented by the candidate in the form of a written thesis. The candidate must demonstrate a capacity for independent thought as well as ability and originality in the application of educational principles or in the development of new generalizations under scientific controls. The thesis may be based upon a product or project of a professional nature, provided that scholarly research is involved. For example, it may be based upon the solution of a professional problem concerned with the development of a curriculum, or a product of creative effort related to education. However, in order to be acceptable as a thesis, the professional project must be accompanied by a written discourse demonstrating the nature of the research and including such theories, experiments, and other rational processes as were used in effecting the final result. The topic and outline of the proposed thesis must have the approval of the doctoral committee.

The completed thesis together with an abstract, typewritten in triplicate, must be filed in the office of the Dean of the Graduate School not later than two weeks prior to the commencement at which the candidate expects to receive the degree.

A *Thesis Information Bulletin*, which gives details concerning format, paper, illustrations, and other items, may be obtained at the Graduate School office.



# PROGRAMS AND COURSES

Programs of study leading to advanced degrees are offered in many major and minor fields. These are listed in the following section, and the major fields are summarized on page 54. Related courses are grouped together under the name of the field. To locate a particular course or group of courses, consult the index.

In general, departments of the University are identified with specific major fields. Thus aeronautical engineering is a major field of study which is offered under the supervision of the Department of Aeronautical Engineering. On the other hand, biological science and comparative literature are major fields for which there are no corresponding departments. In such cases a committee of the Graduate School is responsible for administering the program. In some cases a single department offers work in more than one field. Thus the Department of Civil Engineering offers work in both civil and sanitary engineering.

Applicants for admission are encouraged to consult the person whose name is listed under the major field heading.

**DEGREES**—In those major fields approved for the doctorate, the Ph.D. is normally conferred, although a program leading to the D.Ed. may also be arranged with the consent of the department or committee in charge if such a professional program is appropriate. Similarly, in major fields approved for the master's degree the M.A. or M.S. is normally conferred, but a program leading to the M.Agr., M.B.A., M.Ed., M.Eng., M.F., or M.P.A. may also be available. The D.Ed. and M.Ed. are not limited to the fields of education, but with the consent of the department or committee in charge may be offered in any approved major field appropriate to the preparation of teachers, such as mathematics or English. In this case the program is sponsored by a major department outside the fields of education, such as the Department of Mathematics, but the student's minor is in education.

**MINOR FIELDS**—All major fields listed are also acceptable as minors. In addition, a few fields in which no advanced degrees are offered have been approved as minors for candidates who are majoring in related areas. Such minor fields are identified in the summary on page 54 and by a brief statement under the field heading in the following section.

A candidate's choice of minor field depends upon the particular degree he is seeking and is subject to the approval of his major department. The requirements in each minor field are established by the minor department subject to the regulations of the Graduate Faculty.

**INTERDISCIPLINARY MAJORS**—In addition to the majors listed on page 54, interdisciplinary majors involving two or more departments may be arranged with the approval of the Dean of the Graduate School. These programs are offered under the supervision of appropriate interdepartmental committees.

**OTHER FIELDS**—Fields which have not been approved for either major or minor work, but in which approved courses are offered, are listed in Part II of this bulletin. These courses may be used in graduate programs as electives or as part of a general studies program, subject to the approval of the major department and to the restrictions upon the use of 400 series courses in degree programs.

**COURSE NUMBERING SYSTEM**—Courses in the series 1-399 are not listed in this bulletin because they are strictly undergraduate courses and yield no graduate credit. A graduate student may register for or audit these courses in order to make up deficiencies or fill in gaps in his earlier education but not to meet requirements for an advanced degree.

## PROGRAMS AND COURSES

Courses in the series 400-499 are for upperclassmen with at least junior standing and for graduate students. Only a limited number of credits earned in these courses may be counted toward the requirements for an advanced degree. Detailed regulations concerning the restrictions are given on pages 41 to 45 under the specific requirements for the various master's degrees.

Courses in the series 500-599 are restricted to students registered in the Graduate School, seniors with an average of at least 3.5, and other students who have been granted permission to enroll by the Dean of the Graduate School.

Course numbers 600 and 610 apply to thesis research and are available only to students registered in the Graduate School.

**CREDITS**—A credit is defined as a unit of time approximately equivalent to one week of full-time graduate study. Accordingly, a full-time student having no concurrent employment may earn a maximum of 10 credits in a 10-week term. A "credit" as used in this bulletin, therefore, is identical in meaning with a "semester credit" and should not be confused with a "quarter credit" which is associated with the traditional quarter system. By increasing the length of class periods to 75 minutes, the new Penn State calendar based upon a 10-week term provides for the same amount of time in a given course as did the previous semester plan.

**COURSE DESCRIPTIONS**—A course abbreviation, a number, and a title designate each course. Course designations and official abbreviations are listed at the left-hand margin just above the first course in each group. The figures in parentheses following the course title show the number of credits which may be granted for that course. In the case of courses with variable credits, the number of credits which may be earned in a single term is determined by the department offering the course.

A department may schedule an entire section of a course below the 400 level for fewer credits than the maximum authorized. In 400 and 500 series courses a department may schedule an individual student for fewer credits than the maximum number but in no case for more than the maximum number authorized.

**SCHEDULE OF COURSES**—Not all courses are given each term. A complete list of the courses which will be offered in any specific term is given in the *Timetable*, which is available at nominal cost from the Registrar's Office a few weeks before the beginning of the term. The *Timetable* gives the number of credits being offered in each course, the hours at which the class will meet, the location of the class, and in some cases the instructor's name.

The list of courses given in the *Timetable* is subject to modification at registration time. The number enrolling in a course, the availability of staff members, and other circumstances may result in the cancellation of some courses and the offering of others. Decisions are made by the departments offering the courses.

**RESEARCH AND THESIS WORK**—In general, students registering for work on a master's or a doctor's thesis will, if it is to be done on the University Park Campus, use course number 600 preceded by an abbreviation designating the major field. Thus Aro.E. 600 signifies thesis research in aeronautical engineering. In case such work has been authorized for students not working on the University Park Campus, the number 610 will be used. Credits will be 1 to 10 per term.

It should be assumed that the numbers 600 and 610 are available in all fields in which majors have been approved for advanced degrees although these numbers do not appear in the timetables.

MAJOR  
and  
MINOR  
FIELDS



## GRADUATE FIELDS OF STUDY

- |                                                                      |                                                           |
|----------------------------------------------------------------------|-----------------------------------------------------------|
| Aeronautical Engineering—Ph.D., M.S., M.Eng.                         | Geochemistry—Ph.D., M.S.                                  |
| Agricultural and Biological Chemistry—Ph.D., M.S.                    | Geography—Ph.D., D.Ed., M.S., M.Ed.                       |
| Agricultural Economics—Ph.D., M.S., M.Agr.                           | Geology—Ph.D., M.S.                                       |
| Agricultural Education—Ph.D., D.Ed., M.S., M.Ed.                     | Geophysics—Ph.D., M.S.                                    |
| Agricultural Engineering—M.S.                                        | German—Ph.D., M.A., M.Ed.                                 |
| Agronomy—Ph.D., M.S., M.Agr.                                         | Higher Education—D.Ed.                                    |
| Animal Husbandry—Ph.D., M.S.                                         | History—Ph.D., D.Ed., M.A., M.Ed.                         |
| Animal Nutrition—Ph.D., M.S.                                         | Home Art (minor only)                                     |
| Anthropology—M.A.                                                    | Home Economics Education—Ph.D., D.Ed., M.S., M.Ed.        |
| Architectural Engineering—M.S.                                       | Horticulture—Ph.D., M.S.                                  |
| Architecture—M.S.                                                    | Industrial Arts Education—Ph.D., D.Ed., M.S., M.Ed.       |
| Art—M.A.                                                             | Industrial Engineering—M.S., M.Eng.                       |
| Art Education—Ph.D., D.Ed., M.S., M.Ed.                              | Journalism—M.A.                                           |
| Bacteriology—Ph.D., M.S.                                             | Mathematics—Ph.D., D.Ed., M.A., M.Ed.                     |
| Biological Science—D.Ed., M.Ed.                                      | Mechanical Engineering—Ph.D., M.S., M.Eng.                |
| Biophysics—Ph.D., M.S.                                               | Metallurgy—Ph.D., M.S.                                    |
| Botany—Ph.D., M.S.                                                   | Meteorology—Ph.D., M.S.                                   |
| Business Administration—Ph.D., M.S., M.B.A.                          | Mineral Economics—Ph.D., M.S.                             |
| Business Education—Ph.D., D.Ed., M.S., M.Ed.                         | Mineral Preparation—Ph.D., M.S.                           |
| Ceramic Technology—Ph.D., M.S.                                       | Mineralogy and Petrology—Ph.D., M.S.                      |
| Chemical Engineering—Ph.D., M.S.                                     | Mining Engineering—Ph.D., M.S.                            |
| Chemistry—Ph.D., M.S., M.Ed.                                         | Music—M.A.                                                |
| Child Development and Family Relationships—Ph.D., D.Ed., M.S., M.Ed. | Music Education—D.Ed., M.Ed.                              |
| Civil Engineering—Ph.D., M.S., M.Eng.                                | Nuclear Engineering—M.S., M.Eng.                          |
| Clinical Speech—Ph.D., D.Ed., M.S., M.Ed.                            | Nutrition in Public Health—M.S.                           |
| Clothing and Textiles—Ph.D., D.Ed., M.S., M.Ed.                      | Petroleum and Natural Gas Engineering—Ph.D., M.S.         |
| Comparative Literature—Ph.D., M.A.                                   | Philosophy—Ph.D., D.Ed., M.S., M.Ed.                      |
| Counseling in Education—Ph.D., D.Ed., M.S., M.Ed.                    | Physical Education—Ph.D., D.Ed., M.S., M.Ed.              |
| Dairy Science—Ph.D., M.S.                                            | Physical Science—D.Ed., M.Ed.                             |
| Earth Sciences—M.Ed.                                                 | Physics—Ph.D., M.S.                                       |
| Economics—Ph.D., M.A.                                                | Plant Pathology—Ph.D., M.S.                               |
| Educational Administration—Ph.D., D.Ed., M.S., M.Ed.                 | Political Science—Ph.D., M.A., M.P.A.                     |
| Electrical Engineering—Ph.D., M.S., M.Eng.                           | Poultry Husbandry—Ph.D., M.S.                             |
| Elementary Education—Ph.D., D.Ed., M.S., M.Ed.                       | Psychology—Ph.D., D.Ed., M.S.                             |
| Engineering Mechanics—Ph.D., M.S., M.Eng.                            | Public Administration—M.P.A.                              |
| English—Ph.D., D.Ed., M.A., M.Ed.                                    | Recreation Education—Ph.D., D.Ed., M.S., M.Ed.            |
| Entomology—Ph.D., M.S.                                               | Romance Languages and Literatures—Ph.D., M.A.             |
| Extension Education—M.Agr., M.Ed.                                    | Rural Sociology—Ph.D., M.S., M.Agr.                       |
| Family Economics and Home Management—Ph.D., D.Ed., M.S., M.Ed.       | Sanitary Engineering—M.S., M.Eng.                         |
| Food Service and Housing Administration—M.S., M.Ed.                  | Secondary Education—Ph.D., D.Ed., M.S., M.Ed.             |
| Foods and Nutrition—Ph.D., D.Ed., M.S., M.Ed.                        | Social Studies—M.Ed.                                      |
| Forestry—M.S., M.F.                                                  | Sociology—Ph.D., M.A.                                     |
| Fuel Technology—Ph.D., M.S.                                          | Solid State Technology—Ph.D., M.S.                        |
| General Family Studies—Ph.D., D.Ed., M.S., M.Ed.                     | Speech—Ph.D., D.Ed., M.A., M.Ed.                          |
| Genetics and Breeding—Ph.D., M.S.                                    | Statistics (minor only)                                   |
|                                                                      | Theatre Arts—M.A.                                         |
|                                                                      | Vocational Industrial Education—Ph.D., D.Ed., M.S., M.Ed. |
|                                                                      | Wildlife Management—M.S.                                  |
|                                                                      | Zoology—Ph.D., M.S.                                       |

The degrees listed above are the ones normally conferred in each of the designed major fields. Additional professional degrees, including the M.Agr., M.Ed., and M.Eng., have been authorized in many cases and may be offered at the discretion of the department head and the Dean of the Graduate School. Thus, the M.Ed. has been authorized for all of the above fields in which a master's degree is conferred provided the field is appropriate to the preparation of teachers.

*Part I*  
*Courses in Major and Minor Fields*

AERONAUTICAL ENGINEERING

GEORGE F. WISLICENUS, *Head of the Department*  
233 Hammond Building

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Professor Wislicenus; Associate Professor McCormick; Assistant Professor Li.

Course work and research are available in the following areas: classical and modern hydro-, aero-, and gas-dynamics, including aerochemistry and magneto-hydrodynamics; structures; aeroelasticity; turbomachinery, advanced propulsion; low-speed flight.

The entering student must hold a bachelor's degree in science, mathematics, or engineering and must have completed undergraduate course work in fluid and solid mechanics and in intermediate mathematical analysis.

AERONAUTICAL ENGINEERING (ARO E)

401a,b,c. AERONAUTICAL ENGINEERING PROJECTS (2-12)

402. PROPULSION SYSTEMS DESIGN (2)

404. AIRPLANE AND MISSILE DESIGN (2)

407. DYNAMICS OF LOW-SPEED FLIGHT (3)

408. AERONAUTICAL AND ASTRONAUTICAL TURBOMACHINERY (3)

409. ADVANCED AIRCRAFT STRUCTURES (3)

410. AIRCRAFT AND SPACE PROPULSION (3)

411. AEROELASTICITY (3)

412. THEORETICAL AERODYNAMICS (3)

413. AERONAUTICAL DYNAMICS (3)

414. GASDYNAMICS (3)

415. ADVANCED THEORETICAL FLUID DYNAMICS (3-6)

416-417. AERO-SPACE SEMINAR (1 each)

418. AERO-SPACE SYSTEMS ENGINEERING (3)

501. AIRPLANE STABILITY AND CONTROL (3) General analysis of longitudinal and lateral stability of airplanes; characteristics of flight control devices. Prerequisite: Aro.E. 413.

503. AIRPLANE PERFORMANCE (3) Methods of performance prediction and performance flight testing for high-speed aircraft and missiles. Prerequisite: Aro.E. 413.

504. ROTARY WING AIRCRAFT (3) Types of rotary wing aircraft; helicopter performance, stability, and control; structural and vibration problems. Prerequisites: Aro.E. 407, 409.

505. AEROELASTICITY (3) Vibrating systems with several degrees of freedom; analysis of flutter speed of an airplane wing considering bending, torsion, and aileron motions; other types of aircraft flutter. Prerequisites: Aro.E. 412; E.Mch. 401 or Aro.E. 411.

## AERONAUTICAL ENGINEERING

506. AIRCRAFT STRUCTURES (3-9) Deflections of beams and trusses; statically indeterminate structures; shear-flow analysis and shearing deformations of multi-cell semi-monocoque structures; effects of discontinuities in wing and fuselage structures. Prerequisites: Aro.E. 409, E.Mch. 408.
507. AIRCRAFT GAS TURBINES AND JET PROPULSION ENGINES (3) Types of jet propulsion installations, thermodynamic cycles, analysis of compressors, combustion chambers, and turbines. Prerequisite: Aro.E. 410.
510. AERODYNAMICS OF COMPRESSIBLE FLUIDS (3) One-dimensional motion, shock waves, flow in nozzles, two-dimensional flow, airfoil theory, Prandtl-Meyer flow, method of characteristics. Prerequisite: Aro.E. 412.
511. AERODYNAMICS OF A PERFECT FLUID (3) Euler's dynamic equations, complex potential, conformal transformation, thin airfoils, Biot-Savart law; Prandtl three-dimensional airfoil theory. Prerequisite: Aro.E. 412.
512. AERODYNAMICS OF A VISCOUS FLUID (3) Navier-Stokes equations, incompressible and compressible boundary layer theory, jet and wake problems, hydrodynamic stability, turbulence. Prerequisite: Aro.E. 412.
513. RESEARCH IN AERONAUTICAL ENGINEERING (1-10 per term) Investigation of a theoretical or experimental project in aeronautical engineering.
514. AERONAUTICAL ENGINEERING SEMINAR (1 per term) Current literature and special problems in aeronautical engineering.
515. AERODYNAMICS (3) Airflow, airplane performance. For students with undergraduate training in science or engineering curriculums other than aeronautical engineering.
516. SPECIAL TOPICS IN AIRCRAFT STRUCTURES (3-9)
519. FLUID DYNAMICS OF ROTATING MACHINERY (3-6) Prerequisite: Aro.E. 412.
520. SPECIAL TOPICS IN AERODYNAMICS (3-9)

## AGRICULTURAL AND BIOLOGICAL CHEMISTRY

HOWARD O. TRIEBOLD, *Head of the Department*  
109 Frear Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Althouse, Boucher, Clagett, Frear, Guerrant, Mallette, Pritham, Sullivan, and Triebold; Associate Professor Shigley.

Opportunities for research and graduate study are available in plant metabolism and photosynthesis, intermediary metabolism, nucleic acids, proteins, carbohydrates, lipides, enzymes, vitamins, animal nutrition, poultry nutrition, clinical chemistry, endocrinology, and pesticides.

Entering graduate students should have had at least one year's work in each of the following: general chemistry, analytical chemistry, organic chemistry, physical chemistry, and general physics. Mathematics through integral calculus is also required. Students with limited deficiencies in these subjects may be admitted but must make up such deficiencies concurrently with their graduate studies. Undergraduate courses in biology, biochemistry, and foreign languages will be helpful to the student but are not required for admission.



# AGRICULTURAL AND BIOLOGICAL CHEMISTRY

## AGRICULTURAL AND BIOLOGICAL CHEMISTRY (AB CH)

- |                                               |                     |
|-----------------------------------------------|---------------------|
| 401. GENERAL BIOCHEMISTRY (4)                 | <i>Mr. Clagett</i>  |
| 402. GENERAL BIOCHEMISTRY (4)                 | <i>Mr. Clagett</i>  |
| 403. DAIRY CHEMISTRY (3)                      | <i>Mr. Shigley</i>  |
| 404. FOOD CHEMISTRY (4)                       | <i>Mr. Triebold</i> |
| 417. METHODS OF AGRICULTURAL ANALYSIS (4)     | <i>Mr. Mumma</i>    |
| 425. BIOPHYSICAL CHEMISTRY (4)                | <i>Mr. Mumma</i>    |
| 426. BIOCOLLOIDS (3)                          | <i>Mr. Mallette</i> |
| 436. PHYSIOLOGICAL CHEMISTRY (3)              | <i>Mr. Pritham</i>  |
| 437. PHYSIOLOGICAL CHEMISTRY (3)              | <i>Mr. Pritham</i>  |
| 438. CLINICAL METHODS (3)                     | <i>Mr. Pritham</i>  |
| 439. PROBLEMS IN AGRICULTURAL CHEMISTRY (3-5) |                     |
| 440. PLANT BIOCHEMISTRY (3)                   | <i>Mr. Clagett</i>  |
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501. ENZYMES (2) Investigations and theories concerning nature of enzymes, enzyme action, influence of chemical environment on enzyme action, and biological applications. Prerequisite: A.B.Ch. 437. Fall term. *Mr. Clagett*
503. BIOCHEMICAL PROBLEMS (1-10 per term) Prosecution of an assigned problem under the guidance of an instructor.
505. VITAMINS AND DIETARY DEFICIENCY DISEASES (2) Lectures, conferences, and assigned reading. Prerequisite: A.B.Ch. 437. Fall term, odd years. *Mr. Guerrant*
506. VITAMIN ASSAY METHODS (2) Lectures, conferences, and demonstrations dealing with approved methods of vitamin assay including demonstrations of typical vitamin deficiency syndromes in the rat. Prerequisite: A.B.Ch. 505. Winter term, even years. *Mr. Guerrant*
- 507a. SEMINAR IN PHYSIOLOGICAL CHEMISTRY AND NUTRITION (1 per term)  
*Messrs. Guerrant, Boucher, and Pritham*
- 507b. SEMINAR IN FOODS AND ANALYTICAL CHEMISTRY (1 per term)  
*Messrs. Triebold and Shigley*
- 507c. SEMINAR IN PLANT, ENZYME, AND INSECTICIDE CHEMISTRY (1 per term)  
*Messrs. Frear, Mallette, and Clagett*
508. BIOCHEMICAL LITERATURE (1-3) Assigned readings, reports, and conferences on selected topics in biochemistry. Prerequisite: A.B.Ch. 437.
510. PROTEINS, AMINO ACIDS, AND PEPTIDES (2) Organic, physical, and biological chemistry of the naturally occurring compounds of this group. Prerequisites: A.B.Ch. 425, 437. Fall term. *Mr. Mallette*
511. CARBOHYDRATES (2) Chemical constitution and properties of carbohydrates; their metabolism in plant and animal organisms. Prerequisite: A.B.Ch. 437. Spring term.
512. LIPIDES (2) Investigations on biochemistry of fats and related substances. Winter term. *Mr. Shigley*
516. CHEMISTRY OF THE PESTICIDES (2) Lectures and assigned readings on the chemistry of insecticides, fungicides, herbicides, rodenticides, and related materials. Prerequisite: Chem. 31 or A.B.Ch. 437. Winter term, even years. *Mr. Frear*
517. ENDOCRINE SECRETIONS (2) Chemistry of hormones and their physiological significance. Prerequisite: A.B.Ch. 437. Spring term, even years. *Mr. Pritham*

## AGRICULTURAL AND BIOLOGICAL CHEMISTRY

518. MINERAL METABOLISM (2) Utilization and function of mineral elements in animal nutrition. Prerequisite: A.B.Ch. 437. Spring term, odd years.  
*Mr. Boucher*
519. INTERMEDIARY METABOLISM (3) Processes involved in the utilization of metabolites in plants and animals. Prerequisite: A.B.Ch. 402. Spring term.  
*Mr. Mallette*
520. BIOCHEMICAL METHODS (3) Lectures and advanced laboratory on current techniques pertaining particularly to research on proteins and enzymes. Prerequisite on concurrent: A.B.Ch. 501, 510. Fall term. *Messrs. Clagett and Mallette*
521. BIOCHEMICAL METHODS (3) Lectures and advanced laboratory on current techniques pertaining particularly to research on lipides and carbohydrates. Prerequisite or concurrent: A.B.Ch. 511, 512. Winter term. *Mr. Shigley*

## AGRICULTURAL ECONOMICS

MACKLIN E. JOHN

*Head of the Department of Agricultural Economics and Rural Sociology*  
1 Weaver Building

*Degrees Conferred:* Ph.D., M.S., M.Agr.

*Graduate Faculty:* Professors Barr, Becker, Bennett, Brandow, Butz, Frey, Hutton, Pasto, Pierce, and Southworth; Associate Professors McAlexander and Trotter.

The entering student in the master's program should have as prerequisites 3 credits in agricultural economics, 3 credits in economics, and 3 additional credits in either agricultural economics or economics. If a student lacks some of the prerequisites, he may take them without graduate credit during the early part of his master's program.

### AGRICULTURAL ECONOMICS (AG EC)

407. ADVANCED FARM MANAGEMENT (3) *Mr. Hutton*
420. AGRICULTURAL PRICES (3) *Mr. Brandow*
421. LAND ECONOMICS (3) *Mr. Frey*
426. (A.H. 426) LIVESTOCK MARKETING (3) *Mr. Trotter*
500. SEMINAR IN AGRICULTURAL ECONOMICS (1-6) Review of current literature and problems.
503. RESEARCH METHODS IN FARM MANAGEMENT (1-3) Evaluation of research procedures, methods, results, and needs in the field; emphasis on their application to specific research problems. Prerequisites: Ag.Ec. 6, Econ. 14.
504. AGRICULTURAL PRICE AND INCOME POLICY (3) Analysis of farm prices, income consequences for producers and consumers, and effects on resource use; evaluation of policy, considerations in policy making. Prerequisites: Ag.Ec. 420, Econ. 405.  
*Mr. Brandow*
505. ADVANCED AGRICULTURAL STATISTICS (3) Multiple correlation, curve fitting, analysis of variance, selection of samples, and other techniques applicable to the rural social sciences. Prerequisite: 3 credits in statistics. *Mr. Bennett*
506. ECONOMIC PROBLEMS IN MARKETING SPECIFIC AGRICULTURAL PRODUCTS (3) Profit maximization; psychological and sociological aspects of selling; engineering

## AGRICULTURAL ECONOMICS

aspects of cost reduction; techniques in developing information for managerial decisions.

507. SEMINAR IN FARM MANAGEMENT (1-6) Special problems relating to organization and operation of the farm business. Prerequisites: Ag.Ec. 6, Econ. 14.
510. ADVANCED FARM FINANCE (1-3) Problems and policies in agricultural credit, insurance, and farm financial management. *Mr. Hutton*
515. ECONOMIC PROBLEMS IN THE MARKETING OF DAIRY PRODUCTS (3) Economic problems as they are encountered in the process of marketing; particular attention to governmental regulation in pricing and marketing. *Mr. Pierce*
517. PROBLEMS AND POLICIES OF FARMER CO-OPERATIVES (3) Specific types of co-operative organizations, their problems, policies, and progress; relationships existing among co-operatives, between co-operatives and other business organizations, and between co-operatives and the public. Prerequisite: Ag.Ec. 17. *Mr. Becker*
520. FARM PRICE ANALYSIS (3) Econometric analysis of prices, production, and utilization of farm products; review of research in this field. Prerequisites: Ag.Ec. 420, 505; Econ. 405. *Mr. Brandow*
522. ADVANCED FARM APPRAISAL (3) Land value theory; methods of land valuation; field practice in farm appraisal. *Mr. Frey*
525. RESEARCH METHODS IN RURAL SOCIAL SCIENCES (2) Scientific method in planning and conducting research. Prerequisite: 9 credits in social sciences. *Mr. John*
526. RESEARCH METHODS IN AGRICULTURAL ECONOMICS (2) Application of economic and statistical principles.
534. AGRICULTURAL PRODUCTION ECONOMICS (3) Economic theory applied to agricultural production problems: resource combinations, firm size, uncertainty and expectations, aggregate aspects of production, technological change. *Mr. McAlexander*
535. SEMINAR IN AGRICULTURAL MARKETING (2) *Mr. Southworth*
536. SEMINAR IN DAIRY ECONOMICS (1 per term) *Messrs. Pierce and Butz*

## AGRICULTURAL EDUCATION

DAVID R. McCLAY, *Head of the Department*  
101 Agricultural Education Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors McClay and Stevens; Assistant Professor Hoover.

The requirements for admission to graduate work in agricultural education are 18 credits in professional education courses including educational psychology and practice teaching in vocational agriculture, or certification to teach vocational agriculture. Students who lack any part of these requirements may be admitted but are required to fulfill deficiencies without degree credit.

Minors may be taken in any of the areas of agricultural technology, or, for Master of Science and Doctor of Philosophy degree candidates, in one of the other fields of education, such as educational administration or higher education.



## AGRICULTURAL EDUCATION

### AGRICULTURAL EDUCATION (AG ED)

- 418v. SURVEY OF VOCATIONAL EDUCATION IN AGRICULTURE (1-3) *Mr. Hoover*
- 420v. ADVANCED VISUAL AND OTHER SENSORY AIDS IN TEACHING AGRICULTURE (1-6) *Mr. Anthony*
- 422v. SUPERVISION OF VOCATIONAL EDUCATION IN AGRICULTURE (1-3) *Mr. Anthony*
- 424v. OCCUPATIONAL GUIDANCE IN AGRICULTURAL INDUSTRY (1-4) *Mr. Hoover*
- 426v. YOUNG AND ADULT FARMER EDUCATION IN VOCATIONAL AGRICULTURE (1-4) *Mr. Stevens*
- 434v. AGRICULTURAL DEVELOPMENT (1-6) *Messrs. Love and Bristol*
- 501v. HISTORY OF AGRICULTURAL EDUCATION (1-3) Development of training for agricultural vocations; emphasis upon introduction of agricultural instruction into the high school program. *Mr. Hoover*
- 502v. TEACHING VOCATIONAL AGRICULTURE (1-3) Organization of instruction with respect to vocational objectives, methods of presentation, supervision of practice, pupil evaluation of goals, and follow-up. *Mr. Stevens*
- 503v. RESEARCH IN AGRICULTURAL EDUCATION (1-6 per term) Individual study problems in various phases of agricultural education, such as evaluation of teaching, teaching procedures, and teacher preparation. *Mr. Stevens*
- 504v. AGRICULTURAL EDUCATION SEMINAR (1 per term) *Mr. McClay and Staff*
- 508v. STATE AND COUNTY ADMINISTRATION AND SUPERVISION OF AGRICULTURAL EDUCATION (1-3) Organization and administration of state, county, township, and district systems of agricultural education; state and federal legislation. *Mr. McClay*
- 509v. TEACHER TRAINING IN AGRICULTURAL EDUCATION (1-6) Construction of college curriculums, courses of study, and organization of college departments for training agricultural teachers. *Mr. McClay*
- 520v. SCIENTIFIC METHOD IN THE STUDY OF AGRICULTURAL EDUCATION (1-4) Methods of procedure in investigation and experimentation in education, accompanied by a critical examination of studies made in agricultural education. *Mr. Stevens*
- 521v. SCIENTIFIC METHOD IN THE STUDY OF AGRICULTURAL EDUCATION (1-4) Continuation of Ag.Ed. 520v; emphasis upon statistical techniques for students' individual problems. *Mr. Stevens*
- 524v. ANNUAL PLAN OF WORK (1-3) Detailed study of the agricultural education needs of each student's community and outlining annual plans of work. *Mr. Hoover*
530. AGRICULTURAL COLLEGE TEACHING (3) Selection and organization of subject matter for specific courses, methods of learning, teaching devices, technique of teaching, and measurements of results of teaching. *Mr. McClay*

## AGRICULTURAL ENGINEERING

FRANK W. PEIKERT, *Head of the Department*  
204 Agricultural Engineering Building

*Degree Conferred: M.S.*

*Graduate Faculty: Professors Peikert and Walton; Associate Professor Bartlett.*

## AGRICULTURAL ENGINEERING

Specialization is offered in farm power and machinery, electric power and processing, soil and water conservation engineering, and farm structures.

Prerequisite to major work is the completion of an undergraduate engineering curriculum from a recognized department.

### AGRICULTURAL ENGINEERING (AG E)

- 400. AGRICULTURAL ENGINEERING PROBLEMS (1-7)
- 401. FARM MECHANICS FOR TEACHERS OF VOCATIONAL AGRICULTURE (1½-9)
  - Unit A. *Farm Utilities* (1½)
  - Unit B. *Farm Mechanics* (1½)
  - Unit C. *Farm Engines* (1½)
  - Unit D. *Farm Machinery* (1½)
  - Unit E. *Farm Buildings* (1½)
  - Unit F. *Soil and Water Structures* (1½)
- 402. FUNCTIONAL DESIGN OF FARM STRUCTURES (3)
- 404. FARM MACHINERY (3)
- 405. ADVANCED FARM ELECTRIFICATION (3)
- 406. ADVANCED DAIRY ENGINEERING (3)
- 407. SOIL WATER ENGINEERING (3)
- 410. FARM POWER (3)
- 420. SEMINAR (1)
  
- 500. ADVANCED ELECTRO-AGRICULTURE (1-6) Investigations in the application of electrical energy to processing, storing, and handling agricultural products. Seminar, written reports.
- 501. ADVANCED FARM MACHINERY (1-6) Application of agricultural engineering principles to design and operation of farm machinery. Prerequisite: Ag.E. 410.
- 502. FARM STRUCTURES PROBLEMS (1-6) Analysis of farm structures design problems.
- 507. PROBLEMS IN SOIL WATER ENGINEERING (1-6) Analysis of engineering problems relating to irrigation, drainage, or erosion control.
- 508. ADVANCED PROBLEMS IN FARM MECHANICS (1-15) Problems in farm shop practice and agricultural engineering related to the farm mechanics program of vocational education in agriculture. Prerequisites: Ag.E. 8, 14; or teaching experience in farm mechanics.
- 509. RESEARCH IN AGRICULTURAL ENGINEERING (1-4)
- 520. AGRICULTURAL ENGINEERING SEMINAR (1-3) Reports on research and special topics.

## AGRONOMY

HOWARD B. SPRAGUE, *Head of the Department*  
118 Tyson Building

*Degrees Conferred:* Ph.D., M.S., M.Agr.

*Graduate Faculty:* Professors Fortmann, Higbee, Hunter, Kardos, Matelski, Raleigh, Richer, H. B. Sprague, V. G. Sprague, and Washko; Associate Professors

## AGRONOMY

Cleveland, Marriott, Pfeifer, and Thomas; Assistant Professors Duich, Gorsline, Marshall, McKee, and Starling.

Areas of specialization include soil chemistry; soil conservation; soil classification; soil fertility; soil mineralogy; soil physics; the breeding of corn, small grains, and forage plants; forage management; turf management; potato culture; tobacco culture; weed control; and ecology of crops and pastures. Facilities are available for X-ray diffraction, infrared and petrographic investigations of soils.

Prerequisites for major work in agronomy vary with the area of specialization, but basic courses in chemistry, mathematics, physics, and biological sciences are required. Students who lack some of the course prerequisites may be admitted but are required to take the prerequisite courses without degree credit.

### AGRONOMY (AGRO)

411. BREEDING OF FIELD CROPS (3) *Mr. Thomas*  
416a. SOIL CHARACTERIZATION AND CLASSIFICATION—LECTURE (4) *Mr. Higbee*  
416b. SOIL CHARACTERIZATION AND CLASSIFICATION—PRACTICUM (1) *Mr. Higbee*  
417. FOREST SOILS (3) *Mr. Matelski*  
419. SOIL PROPERTIES (4) *Mr. Baker*  
422. SOIL CONSERVATION (3) *Mr. Kardos*  
423. PASTURE AND GRASSLAND MANAGEMENT (3) *Mr. Washko*  
424. FERTILIZER TECHNOLOGY (3) *Mr. Marriott*  
425. PRINCIPLES OF FIELD CROP PRODUCTION (3) *Messrs. Pfeifer and Thomas*  
431. SOIL FERTILITY AND MANAGEMENT (3) *Mr. Marriott*  
490. AGRONOMIC PROBLEMS (1-6) *Mr. Washko and Staff*
501. ADVANCED SOIL FERTILITY (4) Interpretation of fertility experiments and diagnosis of soil-plant relationships through field appraisal, analysis, and plant symptoms. Prerequisites: Agro. 431, Bot. 406. Winter term, odd years. *Mr. Hunter*
503. AGRONOMY SEMINAR (1) Weekly meeting where papers and discussions will be presented by students and staff members. *Mr. H. B. Sprague*
506. SOIL CHEMISTRY (4) Analyses of important chemical and biochemical reactions occurring in soils, conditions which control these reactions and their importance in soil genesis and plant growth; laboratory work in the more typical and significant analytical procedures; lectures, review of current literature, and practicum. Prerequisites: Agro. 419; A.B.Ch. 417 or Chem. 23. Spring term, even years.
507. SOIL PHYSICS (4) Physical properties of the soil; factors affecting them; their measurements, evaluation, and influence in determination of soil productivity. Prerequisites: Agro. 419, Phys. 215, A.B.Ch. 425. Fall term, even years. *Mr. Kardos*
509. GENETICS OF CROP PLANTS (3) Inheritance in crop plants with particular reference to factor interaction, genetic aspects of linkage and crossing-over, quantitative inheritance, and heterosis. Prerequisite: Bot. (Zool.) 422. Fall term, even years. *Mr. Cleveland*
510. THE APPLICATION OF CYTOGENETICS TO PLANT BREEDING (3) Cytogenetics, including chromosome structure and behavior, chromosome alterations, polyploidy, interspecific hybridization and their applications to plant breeding. Prerequisite: Bot. (Zool.) 422. Fall term, odd years. *Mr. Cleveland*



512. **FIELD PLOT TECHNIQUE (4)** Ramifications of analysis of variance techniques; combining and analyzing data from several experiments; selection of valid error terms. Prerequisite: Math. 8 or Ag. 400. Fall term. *Mr. Starling*
516. **HUMUS (2)** Origin and chemical nature of soil organic matter, its importance in soil processes, and its decomposition. Prerequisites: Agro. 419, 431. Winter term, odd years. *Mr. Richer*
517. **FARM CROPS ECOLOGY (3)** Ecological factors affecting growth and development of farm crops with particular reference to effects of altered environment and management practices. Prerequisites: Agro. 28, Bot. 406. Winter term, even years.
518. **GROWTH AND MANAGEMENT OF FORAGE CROPS (3)** Factors affecting growth and development of forage crops with particular reference to effects of environment, defoliation, and management practices. Prerequisites: Agro. 423, Bot. 406. Spring term, odd years.
519. **THE NATURE OF SOIL MINERALS (3)** Modern methods for identification of the constituent minerals of soils and their relation to soil classification and agricultural practices. Prerequisites: Agro. 1, Chem. 13, G.Sc. 1. Winter term, even years.
545. **THE APPLICATION OF STATISTICS TO FIELD EXPERIMENTS (4)** Use of advanced experimental designs in planning, analyzing, and interpreting experiments; includes lattice designs, factorials, confounding, simple and multiple covariance techniques. Prerequisite: Agro. 512. Winter term. *Mr. Starling*
- \*550. **AGRONOMIC PROBLEMS (1-12)** Provides training in selected areas of agronomy by means of supervised investigations or studies.
582. **SEMINAR IN THE BREEDING AND GENETICS OF FARM CROPS (1-8 per term)**

## ANIMAL HUSBANDRY

RUSSELL C. MILLER

*Head of the Department of Animal Industry and Nutrition*  
202 Armsby Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Bortree, Henning, and Miller; Associate Professor Gobble.

A student may specialize in animal production, animal breeding, and meats. The prerequisite for major graduate work in animal husbandry is the completion of an undergraduate curriculum in animal husbandry or a related animal science area. Students who lack some of the course prerequisites may be admitted but are required to take the prerequisite courses without degree credit.

### ANIMAL HUSBANDRY (A H)

421. **ADVANCED MEAT STUDIES (3)**  
 423. **ADVANCED LIVESTOCK SELECTION (2)**  
 424. **ANIMAL HUSBANDRY SEMINAR (1)**  
 426. **(Ag.Ec. 426) LIVESTOCK MARKETING (3)**  
 431. **ADVANCED MEAT SELECTION AND GRADING (2)**

\*Credits 1-6 per term.

## ANIMAL HUSBANDRY

500. SEMINAR IN ANIMAL HUSBANDRY (1-6)
501. PEDIGREE STUDY (1-6) Research work in breed study history, and analytical study of breed pedigrees, and a complete survey of the herd, flock, or stud book.
502. RESEARCH IN MEATS (1-6 per term) Investigation of methods for handling, cutting, processing, freezing, and curing meat and meat products. Prerequisite: A.H. 421.
503. LIVESTOCK MANAGEMENT (3) Handling of purebred herds and flocks; relation of livestock breeders to the public and methods of developing purebred herds and flocks through careful breeding.
505. ADVANCED ANIMAL BREEDING (1-5) Special problems in animal genetics as applied to breeding and improvement of horses, cattle, sheep, and swine. Prerequisite: A.H. 322.

## ANIMAL NUTRITION

RUSSELL C. MILLER

*Head of the Department of Animal Industry and Nutrition*  
202 Armsby Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Barron, Bratzler, and Miller.

For admission a student must have had A.Ntr. 401 and 402 or their equivalent and must have met the requirements for graduate work in agricultural and biological chemistry. Specialized training is offered in the area of energy metabolism. Candidates for this major select courses from a number of related fields.

### ANIMAL NUTRITION (A NTR)

401. PHYSIOLOGY OF NUTRITION (3)  
402. ENERGY AND PROTEIN METABOLISM (3)

*Mr. Barron*  
*Mr. Barron*

## ANTHROPOLOGY

WILLIAM G. MATHER

*Head of the Department of Sociology and Anthropology*  
240 Sparks Building

*Degree Conferred:* M.A.

*Graduate Faculty:* Professors F. R. Matson and Mook; Associate Professors Baker and Dupree; Assistant Professor Sanders.

Undergraduate preparation for this field must include 12 credits in anthropology and archaeology or their equivalent and at least 6 credits in related sciences, with breadth of background preferably in the arts and sciences. With special permission exceptional students will be admitted provided they make up course deficiencies without graduate credit.

Sociology may be chosen as a minor field by students majoring in anthropology.

ANTHROPOLOGY (ANTHY)

- |                                                                                                                                                                                                 |           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 401. PHYSICAL ANTHROPOLOGY: HUMAN EVOLUTION (3)                                                                                                                                                 | Mr. Baker |
| 402. HUMAN ECOLOGY (3)                                                                                                                                                                          | Mr. Baker |
| 442. ANTHROPOLOGY OF THE NEW WORLD (3)                                                                                                                                                          |           |
| 443. ANTHROPOLOGY OF THE OLD WORLD AND MIDDLE EAST (3-6)                                                                                                                                        | Mr. Mook  |
| 445. PRIMITIVE SOCIETY (3)                                                                                                                                                                      | Mr. Mook  |
| 448. ANTHROPOLOGICAL THEORY (3)                                                                                                                                                                 |           |
| 540. ANTHROPOLOGICAL THEORY (3) Theory used in culture-historical, sociological, and psychological interpretations.                                                                             | Mr. Mook  |
| 541. RESEARCH METHODS IN ANTHROPOLOGY (3-6) Principles, techniques, and examples of both field and library research in anthropology. Students will prepare research plans for class discussion. |           |
| 545. SEMINAR IN ANTHROPOLOGY (1-9) Critical analysis of research in selected areas of anthropology. Prerequisites: Anthy. 45, 445.                                                              | Mr. Mook  |

ARCHAEOLOGY (ARCHY)

- |                                                |            |
|------------------------------------------------|------------|
| 400-401. ARCHAEOLOGY OF THE NEAR EAST (3 each) | Mr. Matson |
| 403. ARCHAEOLOGY OF THE NEW WORLD (3)          | Mr. Matson |

## ARCHITECTURE and ARCHITECTURAL ENGINEERING

MILTON S. OSBORNE, *Head of the Department of Architecture*  
302 Sackett Building

*Degree Conferred:* M.S.

*Graduate Faculty:* Professors Hajjar, Hallock, Osborne, and Richardson; Associate Professors Albright and Reis.

To enter graduate study in the field of architecture, a degree of Bachelor of Architecture, Bachelor of Science in Architecture, or Bachelor of Fine Arts in a five-year curriculum in architecture is required.

To enter graduate study in the field of architectural engineering, a degree of Bachelor of Architectural Engineering or Bachelor of Science in Architectural Engineering in a five-year curriculum is required.

ARCHITECTURE (ARCH)

- |                                                   |
|---------------------------------------------------|
| 411. ADVANCED ARCHITECTURAL DESIGN (6)            |
| 412. ADVANCED ARCHITECTURAL DESIGN AND THESIS (5) |
| 413. ADVANCED ARCHITECTURAL DESIGN AND THESIS (5) |
| 421. (A.A.H. 421) CONTEMPORARY ARCHITECTURE (3)   |



## ARCHITECTURE

501. ARCHITECTURAL DESIGN (4-8) Problems in advanced planning and design, including study of group composition. Practicum and seminar.  
*Mr. Osborne and Staff*
502. ARCHITECTURAL RESEARCH (2-12) Prosecution of assigned problems under the guidance of an instructor.  
*Mr. Osborne and Staff*
503. ARCHITECTURAL HISTORY RESEARCH (3-12) Original research in architectural history. Seminar and written reports.  
*Mr. Dickson and Staff*

## ARCHITECTURAL ENGINEERING (A E)

401. ARCHITECTURAL ENGINEERING (3)
402. ARCHITECTURAL ENGINEERING (4)
403. ARCHITECTURAL ENGINEERING (3)
430. ARCHITECTURAL ENGINEERING (3)
431. ARCHITECTURAL ENGINEERING (3)
432. ARCHITECTURAL ENGINEERING (4)
433. ARCHITECTURAL ENGINEERING THESIS (2)
434. ARCHITECTURAL ENGINEERING THESIS (2)
435. ARCHITECTURAL ENGINEERING THESIS (3)
441. INTEGRATION OF ARCHITECTURAL ENGINEERING SYSTEMS (3)
442. RESEARCH IN ARCHITECTURAL ENGINEERING (1-6)
445. ARCHITECTURAL ENGINEERING SEMINAR (1-6)
451. FUNDAMENTALS OF NUCLEAR DEFENSE PLANNING AND DESIGN (3)
502. ARCHITECTURAL ENGINEERING (3-8) Advanced structural design in steel and reinforced concrete. Lectures and class criticism. Practicum and seminar.  
*Mr. Richardson and Staff*
503. ARCHITECTURAL ENGINEERING (4-8) Continuation of A.E. 502 in which problems of wind bracing in tall buildings, rigid frames, and heavy-framed constructions are studied. Practicum and seminar.  
*Mr. Richardson and Staff*
504. ARCHITECTURAL ENGINEERING (4-8) Statically indeterminate stresses in steel and reinforced concrete buildings; area moment, slope deflection, and moment distribution methods. Recitation and seminar.  
*Mr. Richardson and Staff*
542. ADVANCED PROBLEMS AND RESEARCH IN ARCHITECTURAL ENGINEERING (2-12) Investigation, analysis, and preparation of comprehensive report on subject relating to special problems in architectural engineering systems. Prerequisite: graduate standing.
545. ARCHITECTURAL ENGINEERING SEMINAR (1-6) Current literature and special problems in architectural engineering; presentation of technical papers. Prerequisite: graduate standing.
551. ADVANCED NUCLEAR DEFENSE PLANNING AND DESIGN I (3) Weapons effects data; dynamic strength of materials and structural elements; dynamic design; architectural, structural, electrical, and mechanical requirements for shelters. Prerequisites: A.E. 4, 5, 451; E.Mch. 12.  
*Mr. Albright*
552. ADVANCED NUCLEAR DEFENSE PLANNING AND DESIGN II (3) Blast-resistant design of framed structures, shear wall structures, arches, domes, and underground structures; radiation shielding characteristics of building materials. Prerequisites: A.E. 431, 432, 551; Phys. 237.  
*Mr. Albright*
553. SELECTED PROBLEMS IN NUCLEAR DEFENSE RESEARCH (1-6) Prerequisite or concurrent: A.E. 451.  
*Mr. Albright*

## ART

JULES HELLER, *Director of the School of the Arts*  
105 Sparks Building

*Degree Conferred:* M.A.

*Graduate Faculty:* Professors Dickson, Hyslop, Weisman, and Zoretich; Associate Professor Enggass; Assistant Professor Shobaken.

Students may specialize in studio work or in the history of art and architecture. For admission at least 18 credits of undergraduate work in art are required. The graduate program is contingent upon the student's undergraduate preparation. If an inadequacy exists, the student will be required to make up the deficiency without degree credit.

## ART (ART)

- 400. ADVANCED OIL PAINTING (3-12)
- 410. WATER-COLOR PAINTING: LANDSCAPE, STILL LIFE, AND FIGURE (3-9)
- 420. APPLIED DESIGN (3-9)
- 431. SCULPTURE (2-6)
- 440. PRINTMAKING (2-6)
- 490. LIFE DRAWING (3)
- 500. ART RESEARCH (2-6) Prosecution of assigned problems under the guidance of an instructor.
- 510. ADVANCED PAINTING (2-12)
- 531. ADVANCED SCULPTURE (2-12)
- 540. ADVANCED PRINTMAKING (2-12)

## ART AND ARCHITECTURAL HISTORY (A A H)

- 403. STUDIES IN THE ARTS OF THE MIDDLE AGES (3)
- 409. MOVEMENTS IN CONTEMPORARY ART (3-6)
- 410. TASTE AND CRITICISM IN ART (3)
- 413. PROBLEMS IN ART HISTORY (3-6 per term)
- 421. (Arch. 421) CONTEMPORARY ARCHITECTURE (3)
- 448. HISTORY OF PRINTS AND DRAWINGS (3)
- 502. SEMINAR IN MEDIEVAL ART (3-6) Original research into problems dealing with the art of the middle ages.
- 503. ART HISTORY RESEARCH (3-6) Original investigation in art history, to be pursued independently or concurrently with course work in particular fields.
- 504. SEMINAR IN RENAISSANCE ART (3-6) Investigations in the area of Renaissance art, centering around major masters and monuments.
- 505. SEMINAR IN BAROQUE ART (3-6) Investigations in the area of Baroque art centering around major masters and monuments.
- 506. SEMINAR IN MODERN ART (3-6) Lectures, readings, reports, and discussions in the field of modern art.
- 508. SEMINAR IN AMERICAN ART (3-6) Studies in the field of American art involving original research.

## ART

### ART—MUSIC—THEATRE (A M T)

- 400. CONTEMPORARY FORMS IN ART, MUSIC, THEATRE I (3)
- 401. CONTEMPORARY FORMS IN ART, MUSIC, THEATRE II (3)

## ART EDUCATION

EDWARD L. MATTIL, *Head of the Department*  
106 Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Beittel and Mattil; Associate Professors Cataldo, Chomicky, and Pappas; Assistant Professor Edmonston.

Graduate programs in this field prepare students for careers in public school art teaching, art supervision, college teaching, or research. To be admitted without deficiencies, the student is expected to have completed either a baccalaureate program in art education or a program leading to certification. Such a program would include work in art studio, art history, art education, education, and psychology. Deficiencies may be made up by course work which is not counted as credit toward an advanced degree.

All students are expected to complete one year of teaching before receiving the master's degree and two years of teaching before receiving the doctor's degree.

### ART EDUCATION (A ED)

- 404. METHODS OF GRAPHICS AND ILLUSTRATIONS (3)
- 414. ADVANCED CRAFTS FOR TEACHERS (3-6)
- 420. CERAMICS FOR TEACHERS (3)
- 434. ART APPRECIATION IN THE EDUCATIONAL PROGRAM (3)
- 435. ART IN THE ELEMENTARY SCHOOL (3)
- 436. ART IN THE SECONDARY SCHOOL (3)
- 486. CURRENT PROBLEMS IN ART EDUCATION (2-3)
- 487. MURAL PAINTING IN SCHOOLS (3)
- 488. ADVANCED MURAL PAINTING IN SCHOOLS (3)
- 489. ART EXPERIENCES WITH CHILDREN (3)
- 501. SEMINAR IN ART EDUCATION (1-6) The analysis of fundamental concepts derived from related disciplines; the examination of current problems; current literature.
- 504. ADVANCED METHODS IN GRAPHIC PROCESSES (3) Exploration through laboratory experience of printing method: etching, silk screen, linoleum, or other; applications in teaching.
- 514. FUNCTIONAL RELATIONSHIPS IN CRAFTS (3) Relationships of material design and purpose in crafts discussed by means of outstanding products of different materials, periods, and cultures. Prerequisite: 6 credits in crafts or 3 in design and 3 in advanced crafts.
- 516. ANALYSIS OF THREE-DIMENSIONAL PROCESSES IN ART (3) Three-dimensional processes analyzed with regard to kinetic, textural, form, and other functions.
- 520. ADVANCED CERAMIC ART (3) Intensified exploration of throwing, glazing, and firing processes as related to aesthetic considerations in contemporary art forms and past cultures. Prerequisite: A.Ed. 420.



534. CREATIVE ART ACTIVITY FOR THE HANDICAPPED (3) Specific methods for development of creative art activity with the physically, mentally, emotionally, and socially handicapped; adjustive effect upon them. Prerequisite: 6 credits in art education or 6 in special education or 6 in psychology.
535. ADMINISTRATION AND SUPERVISION OF ART EDUCATION PROGRAMS (3) The problems and responsibilities of the city, county, and state art supervisor; curriculum, facilities, financing, supervision, in-service training, and reporting. Prerequisites: A.Ed. 435, 436. *Mr. Mattil*
588. HISTORY OF ART EDUCATION (3) Historical development of philosophies in art education in the United States and abroad. *Mr. Beittel*
598. RESEARCH METHODS IN ART EDUCATION (3-6) Orientation in research methods; findings and designs related to the study of problems in art education. *Messrs. Beittel and Edmonston*
599. RESEARCH IN ART EDUCATION (1-6) Independent research, under an adviser, to be terminated by a scholarly report proportionately comparable in quality to a master's thesis. Prerequisite: 15 credits in art education on the 400 and 500 level, including A.Ed. 598.

## BACTERIOLOGY

ROBERT W. STONE, *Head of the Department*  
204 Patterson Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Cone, Dunne, Ludwig, Reid, and Stone; Associate Professors Gentry, Heist, Lindstrom, and Zimmerman; Assistant Professors Casida and Kinsloe.

Specialized areas of study include bacterial physiology, soil microbiology, food and industrial microbiology, immunology, and virology. There is opportunity for research in animal disease in co-operation with the Department of Veterinary Science.

Prerequisites for admission are 20 credits in chemistry including quantitative analysis and organic chemistry, and 20 in biological science including 8 in microbiology. It is possible to substitute additional chemistry credits for part of the biology requirement.

### BACTERIOLOGY (BACT)

401. GENERAL MICROBIOLOGY (4)  
407. BACTERIOLOGY PROBLEMS (2-9)  
410. IMMUNOLOGY AND SEROLOGY (4)  
411. BACTERIOLOGICAL SURVEY (1)  
412. ADVANCED BACTERIOLOGY (4)  
413. SOIL MICROBIOLOGY (4)  
414. FOOD MICROBIOLOGY (4)  
416. INDUSTRIAL MICROBIOLOGY (4)
507. SEMINAR (1 per term) Reports on current fields of research.
508. PHYSIOLOGY OF BACTERIA (2-4) Composition, nutrition, and growth of microorganisms; influence of physical and chemical environment on metabolism.

## BACTERIOLOGY

509. FERMENTATION (2) Chemical activities of microorganisms; mechanisms of fermentative and oxidative metabolism.
510. LABORATORY IN FERMENTATION (2) Laboratory procedures and problems in fermentation to accompany Bact. 509.
512. BACTERIOLOGICAL TECHNIQUES (1-6) Practice in special laboratory techniques including manometry, tissue culture, and serology.
515. (V.Sc. 515) VIROLOGY (2-4) Rickettsial and viral agents parasitizing man, animals, and microorganisms. Prerequisite: Bact. 410.
516. BACTERIAL GENETICS (2-4) Mechanisms of variation in microorganisms including mutation, adaptation, sexual recombination, transduction, and transforming factors. Prerequisite: 3 credits each in bacteriology and genetics.

## BIOLOGICAL SCIENCE

LEON R. KNEEBONE, *Chairman of the Committee on Biological Science*  
117 Buckhout Laboratory

*Degrees Conferred:* D.Ed., M.Ed.

The program in biological science is designed primarily to meet the needs of secondary school science teachers. The academic degrees M.S. and Ph.D. are not offered in biological science but are available in agricultural and biological chemistry, bacteriology, botany, entomology, genetics and breeding, plant pathology, and zoology.

In order to enter a program for a higher degree with a major in biological science, the candidate should present 30 credits in the natural sciences, including at least one year of chemistry, and 18 credits in education, including educational psychology and practice teaching. As many as 6 credits may be made up as undergraduate deficiencies after the candidate is admitted to the Graduate School.

The candidate for the M.Ed. degree must take at least 24 credits in the biological and physical sciences with a minimum of 15 credits in the biological sciences, including at least 6 in the animal sciences and 6 in the plant sciences. In addition, at least 6 credits in educational foundations and a term paper are required.

A reading knowledge of one foreign language is required for the D.Ed. degree.

## BIOPHYSICS

ERNEST C. POLLARD  
*Chairman of the Committee on Biophysics*  
101 Walker Laboratory

*Degrees Conferred:* Ph.D., M.S.

This program is designed for those interested in applying physical methods to the problems of living systems. A student with a degree in physics, biology, chemistry, or engineering is eligible for admission. Opportunity to make up possible undergraduate deficiencies is provided in the program.

Courses are offered in molecular biophysics (an introductory course), nucleic acids, radiation action, cellular physiology, biophysical instrumentation, general biophysics,

physics of viruses, and physics of the cell. Advice on the selection of other courses to meet the needs of each student is provided by a committee. These include courses in physics, chemistry, biochemistry, zoology, and bacteriology.

Theses may be supervised by faculty members of several departments who have competence in biophysics.

## BOTANY

ALVIN R. GROVE

*Acting Head of the Department of Botany and Plant Pathology*  
206 Buckhout Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Fergus, Grove, Kneebone, Wahl, and Wright; Associate Professors Grun, Hill, and Kovar; Assistant Professors Hillson and Hovin.

The student may specialize in plant anatomy, cytology, ecology, genetics, morphology, mycology, physiology, plant pathology, or taxonomy. An entering student should present 27 credits of undergraduate work in botany or 21 credits in botany and 6 in biological science. As many as 6 credits may be made up as undergraduate deficiencies after the candidate has been admitted to the Graduate School.

In addition to its excellent facilities for research in various phases of botany, genetics, and plant pathology, the department is equipped with a Gamma Radiation Laboratory for the study of irradiation effects upon plants and other facets of radiation biology.

*See also "Plant Pathology" and "Genetics and Breeding."*

### BOTANY (BOT)

- |                                                                                                                                                                                                                                                                                   |                                |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| 400. COMPARATIVE PLANT MORPHOLOGY (4)                                                                                                                                                                                                                                             | Mr. Hillson                    |
| 405. (Zool. 405) GENERAL CYTOLOGY (3)                                                                                                                                                                                                                                             | Mr. Grun                       |
| 406. PLANT PHYSIOLOGY (4)                                                                                                                                                                                                                                                         | Mr. Bell                       |
| 407. PLANT ANATOMY (3)                                                                                                                                                                                                                                                            | Mr. Hillson                    |
| 409. PLANT ECOLOGY (3)                                                                                                                                                                                                                                                            | Mr. Kovar                      |
| 414. TAXONOMY OF VASCULAR PLANTS (3)                                                                                                                                                                                                                                              | Mr. Wahl                       |
| 419. (P.Path. 419) MYCOLOGY (3)                                                                                                                                                                                                                                                   | Mr. Fergus                     |
| 421. BOTANICAL TECHNIQUE (3)                                                                                                                                                                                                                                                      | Mr. Grove                      |
| 422. (Zool. 422) ADVANCED GENETICS (3)                                                                                                                                                                                                                                            | Messrs. Wright, Grun, and Nash |
| 424. (W.U. 424) COMMERCIAL TROPICAL WOODS (3)                                                                                                                                                                                                                                     |                                |
| 433. (Zool. 433) GENETICS, EUGENICS, AND EVOLUTION FOR TEACHERS (3)                                                                                                                                                                                                               | Messrs. Wright and Grun        |
| 500. PLANT PHYSIOLOGY SEMINAR (1 per term) Selected topics from recent literature; staff and student reports on current research. Winter term.                                                                                                                                    |                                |
| 501. THE PHYSIOLOGY OF THE FUNGI (3) Chemical composition, metabolism, toxic and stimulating agencies, spore germination, growth and irritability of the fungi. Prerequisites: Bot. 406, 419, and preferably Chem. 32. Winter term, odd years.                                    |                                |
| 505. (Zool. 505) CYTOLOGY AND CYTOGENETICS (3) Chromosome mechanism of heredity; relationship between plant and animal evolution and breeding and changes in chromosomes; cytological and cytochemical techniques. Prerequisite: Bot. (Zool.) 405 or 422. Spring term, odd years. |                                |



## BOTANY

506. COMPARATIVE ANATOMY OF VASCULAR PLANTS (3) Structure of the Tracheophyta from a phylogenetic standpoint. Prerequisite: Bot. 407. Spring term, even years. *Mr. Hillson*
511. ADVANCED PLANT PHYSIOLOGY (3) Physiology of plants including energy relations, synthesis, and metabolism. Prerequisite: Bot. 406. Fall term, odd years.
512. ADVANCED PLANT PHYSIOLOGY (3) Continuation of Bot. 511. Physiology of plants including nutrition, growth, and development. Prerequisite: Bot. 406. Winter term, even years.
516. ECOLOGICAL PLANT GEOGRAPHY (3) Distribution of plant communities; environmental factors which influence their present distribution; geological-historical development of plant communities, their past distribution. Prerequisite: Bot. 409. Winter term, odd years. *Mr. Kovar*
518. (P.Path. 518) SPECIAL PROBLEMS (1-12) The prosecution of an assigned problem under the guidance of a staff member. Throughout the year as arranged. By appointment.
521. MOLDS, YEASTS, AND ACTINOMYCETES (3) Morphology and taxonomy of fungi important in microbiology; identification and techniques of study. Fall term, odd years. *Mr. Fergus*
522. (P.Path. 522) MYXOMYCETES, PHYCOMYCETES, AND ASCOMYCETES (4) Morphology, taxonomy, phylogeny, and life histories; identification and field work. Prerequisite: Bot. (P.Path.) 419. Winter term, even years. *Mr. Fergus*
523. (P.Path. 523) BASIDIOMYCETES AND FUNGI IMPERFECTI (4) Morphology, taxonomy, phylogeny, and life histories. Prerequisite: Bot. (P.Path.) 419. Spring term, even years. *Mr. Fergus*
524. (Zool. 524) SEMINAR IN GENETICS (1 per term) *Messrs. Wright and Grun*
525. STRUCTURE OF ECONOMIC PLANTS (3) Developmental and reproductive features of field and vegetable crops. Fall term, odd years. *Mr. Grove*
- 527a,b. PLANT BIOLOGY FOR TEACHERS (3 each) (a) Structure and physiology; (b) reproduction processes, development and relationships of plant groups. Methods of obtaining materials and setting up experiments. Designed for teachers and prospective teachers. Prerequisite: general biology or general botany courses. Summer term only; a and b given in alternate years. Bot. 527a must be taken before 527b. Not accepted for credit for the M.S. or Ph.D. degree. *Mr. Westerfeld*
528. (Zool. 528) POPULATION GENETICS (3) Factors affecting gene frequency, genotype frequency, genotype-environmental interaction, and genetic relationship in natural and artificial populations. Winter term, even years.
532. ADVANCED SYSTEMATIC BOTANY (2) Taxonomic principles including taxon concepts and criteria, nomenclature, classificatory systems, geographic distribution, speciation, and taxonomic literatures. Prerequisite: Bot. 14 or 414. Winter term, even years. *Mr. Wahl*
533. (Zool. 533) PROBLEMS IN GENETICS (2-6) Problems to suit needs of individual students; conferences and laboratory work. Prerequisite: Bot. (Zool.) 422. *Messrs. Wright and Grun*
534. MORPHOLOGY OF MARINE AND FRESH-WATER NONVASCULAR PLANTS (4) Classification, structure, development, and phylogenetic relationships of algae, liverworts, and mosses. Prerequisite: Bot. 421. Fall term, even years. *Mr. Hillson*

535. MORPHOLOGY OF THE TRACHEOPHYTA EXCLUSIVE OF ANGIOSPERMS (3) Origin, developmental tendencies, structure, and paleobotanical evidence. Winter term, odd years. *Mr. Grove*
536. MORPHOLOGY OF ANGIOSPERMS (3) Floral origin and development, fertilization, embryogeny, seed and fruit development. Spring term, odd years. *Mr. Grove*
537. (Sec.Ed. 537, Zool. 537) WORKSHOP IN THE BIOLOGICAL SCIENCES (3) Projects designed for teachers of biology in the secondary schools. Summer term only.
538. BOTANY SEMINAR (1 per term) Presentation and discussion of selected topics.

## BUSINESS ADMINISTRATION

ROBERT L. CLEWETT

*In Charge of Graduate Programs in Business Administration*  
122 Boucke Building

*Degrees Conferred:* Ph.D., M.S., M.B.A.

*Graduate Faculty:* Professors Bradley, Cook, Hexner, Kniffin, McKinley, G. K. Nelson, Pashek, Saylor, Strong, Waters, and Wherry; Associate Professors Babione, Beik, Carzo, Clewett, Colwell, Greenlaw, Kautz, Phalan, Richards, Sauerlender, and Schrader; Assistant Professors Iwand and Sussman.

The M.B.A. program is designed for those desiring professional training in business administration, regardless of their undergraduate background, in preparation for a career in either business or teaching. An applicant with little or no training in business administration may be admitted to the M.B.A. program and may schedule necessary preparatory courses while pursuing the graduate program. Three credits are required as preparatory courses in each of the following: accounting, business law, business statistics, economics, finance, management, and marketing.

The M.S. and Ph.D. degrees with a major in business administration are designed for those interested primarily in research and teaching.

For admission to these programs, a minimum of 18 acceptable undergraduate credits in the fields of accounting, commerce, economics, and business statistics—including at least 6 in economics and 3 in business statistics—is required. An applicant may be admitted with slight specific deficiencies which must be made up without degree credit.

Applicants for the various graduate programs in business administration are required to take the Admission Test for Graduate Study in Business given by the Educational Testing Service and used by leading graduate business schools throughout the country to supplement other criteria for admission. Candidates are strongly urged to take the test at the earliest possible date. The test will be given at University Park and at numerous locations in most states and foreign countries in November, February, April, and July. For dates and locations see the *Bulletin of Information*, Admission Test for Graduate Study in Business, published by the Educational Testing Service, 20 Nassau Street, Princeton, New Jersey. Applicants should read the bulletin carefully. All arrangements for taking the test must be made directly with the Educational Testing Service.

## ACCOUNTING (ACCTG)

401. ADVANCED ACCOUNTING (3)  
403. ADVANCED AUDITING (3-9)



## BUSINESS ADMINISTRATION

- 404. COST AND BUDGETARY CONTROL (3)
- 406. ADVANCED FEDERAL TAX ACCOUNTING (3)
- 407. CONTEMPORARY ISSUES IN ACCOUNTING (3)
- 408. GOVERNMENTAL ACCOUNTING (3)
- 409. MACHINE AND ELECTRONIC ACCOUNTING METHODS (3)
  
- 500. ACCOUNTING SEMINAR (3-6)
  
- 502. MANAGERIAL ACCOUNTING (3-6) Accounting techniques as control devices in business and industry; the use of quantitative data for policy decisions.
  
- 511. INTERPRETATION OF ACCOUNT DATA (3)
  
- 520. PROBLEMS IN ACCOUNTING (3-6) Planned individual projects involving library, laboratory, or field work.

## COMMERCE (COM)

- 406. INVESTMENT ANALYSIS (3)
- 408. CASE STUDIES IN BANKING AND FINANCE (3)
- 418. ESTATE PLANNING (3)
- 424. MARKETING RESEARCH (3)
- 427. RETAIL BUYING AND MERCHANDISING (3)
- 461. REGULATION OF TRANSPORT CARRIERS (3)
- 462. PROBLEMS IN TRADE AND TRANSPORTATION (3)
- 491. URBAN LAND UTILIZATION (3)
  
- 500. CASE STUDIES IN BUSINESS ADMINISTRATION (3) Case studies of business and management policy with respect to procurement, production, selling, finance, accounting, relations with government, labor, and the public.
  
- 501. COMMERCE SEMINAR (3-6) Reports on research in selected fields of commercial activities.
  
- 502. SEMINAR IN BUSINESS MANAGEMENT (3-6)
  
- 503. TRANSPORTATION AND PUBLIC UTILITY SEMINAR (3-6)
  
- 504. PROBLEMS IN COMMERCE (3-6) Planned individual projects involving library, laboratory, or field work.
  
- 506. SEMINAR IN INVESTMENTS AND CORPORATION FINANCE (3-6)
  
- 517. INTERNATIONAL BUSINESS PRACTICES (3) Practices of exporters and importers dealing in commodities traded in world markets under competition, monopoly, or governmental control. Prerequisite: Com. 162.
  
- 523. SEMINAR IN MARKETING (3-6) Research in modern marketing trends.
  
- 525. CASE STUDIES IN INSURANCE (3-6) Analysis of management's insurance problems, such as the feasibility of self-insurance; proper allocation of insurance premiums and coverage in selected industries, etc. Prerequisites: Com. 180, 280.
  
- 536. SALES MANAGEMENT SEMINAR (3) Principles of sales planning and administration; co-ordination of selling with advertising, promotion, production, and accounting; use of market research selling costs and budgets.
  
- 574. BUSINESS RESEARCH (1-3) A project paper, comparable in quality and scope of work to a graduate thesis, on problems of a company. Prerequisite: 15 credits of 400 and 500 courses in business administration.



## BUSINESS ADMINISTRATION

577. ADMINISTRATIVE INTEGRATION (3) An analysis of co-ordination of the functional areas of business in relation to over-all company objectives. Prerequisite: 15 credits of 400 and 500 courses in business administration.

### MANAGEMENT (MGMT)

430. ADMINISTRATIVE MANAGEMENT (3)  
435. CASES IN PUBLIC RELATIONS (3)

## BUSINESS EDUCATION

JAMES H. MOYER

*Head of the Department of Secondary Education*  
207A Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

This program provides advanced preparation for teachers of business subjects for secondary schools and colleges. The subject-matter areas encompass secretarial, accounting, retailing, clerical, and general business sequences. The program may be adapted for the preparation of supervisors of business education.

A minimum of 18 acceptable undergraduate credits in education and psychology plus a minimum of 30 credits in business and business education subjects are required for admission.

All candidates specializing in business education are encouraged to acquire a general education in the social sciences, the behavioral sciences, and the humanities.

The following courses in business education are described on page 162 under the heading Secondary Education: Sec.Ed. 456, 459, 460, 461, 462, 463, 466, 467, 468, 511, 575, 576, 577, and 578.

## CERAMIC TECHNOLOGY

G. W. BRINDLEY, *Head of the Department*  
214 Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Brindley, Buessem, and Hummel; Associate Professors Williamson and Rindone.

The background for admission is a bachelor's degree in ceramics or in one of the related physical sciences. A knowledge of differential and integral calculus is required together with adequate physics and chemistry.

In view of the wide field covered by ceramic technology, the graduate courses may be selected with a bias toward physical ceramics, chemical ceramics, or glass technology. This makes it easily possible for students whose major subject for the bachelor's or master's degree has been either physics or chemistry to take appropriate graduate studies in ceramic technology.

Special facilities exist for research in the areas of clay mineralogy, phase diagram and related studies, ferrite and ferroelectric studies, glass technology, and high temperature reaction kinetics.

### CERAMIC TECHNOLOGY (CER T)

400. CRYSTAL CHEMISTRY OF CERAMIC MATERIALS (2)  
401. CERAMIC BODIES AND GLAZES (2)

*Mr. Brindley*  
*Mr. Hummel*

## CERAMIC TECHNOLOGY

- |       |                                                         |                       |
|-------|---------------------------------------------------------|-----------------------|
| 402.  | PRINCIPLES OF CERAMIC ENGINEERING (3)                   | <i>Mr. Williamson</i> |
| 404.  | CERAMIC SEMINAR (1)                                     | <i>Mr. Hummel</i>     |
| 405.  | CERAMIC RESEARCH AND DESIGN (1)                         |                       |
| 406.  | RHEOLOGY AND FLUID PROPERTIES OF CERAMIC SYSTEMS (2)    | <i>Mr. Williamson</i> |
| 407.  | CERAMIC MATERIALS LABORATORY (2)                        | <i>Mr. Williamson</i> |
| 408.  | HEAT TREATMENT OF CERAMIC MATERIALS (1)                 | <i>Mr. Stubican</i>   |
| 409.  | HEAT TREATMENT LABORATORY (2)                           | <i>Mr. Stubican</i>   |
| 410.  | PHASE RELATIONS IN CERAMIC SYSTEMS (3)                  | <i>Mr. Hummel</i>     |
| 411.  | PRINCIPLES OF CERAMIC PROCESSES (2)                     | <i>Mr. Buessem</i>    |
| 412.  | SURFACE CHEMISTRY OF CERAMIC MATERIALS (1)              | <i>Mr. Weyl</i>       |
| 415.  | PRINCIPLES OF GLASS TECHNOLOGY (3)                      | <i>Mr. Rindone</i>    |
| 420.  | REFRACTORIES (2)                                        | <i>Mr. Stubican</i>   |
| 425.  | CERAMIC RESEARCH AND DESIGN (2)                         |                       |
| 430.  | ELECTROCERAMICS (1)                                     | <i>Mr. Buessem</i>    |
| *450. | CONSTITUTION AND PHYSICAL MEASUREMENTS LABORATORY (1-2) |                       |
| *451. | CONSTITUTION AND PHYSICAL MEASUREMENTS LABORATORY (1-2) |                       |
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500. SEMINAR IN CERAMIC TECHNOLOGY (1-2 per term) Current developments in ceramic technology and related fields. Required of all graduate students in ceramic technology. *Mr. Brindley and Staff*
501. COLLOIDAL BEHAVIOR OF CLAYS AND MUDS (2-4) Colloidal properties of ceramic clays, glazes, drilling muds, filtering and bleaching clays, and kindred systems. *Mr. Williamson*
503. USE OF PHASE EQUILIBRIA DATA IN CERAMIC TECHNOLOGY (2-5) Phase equilibria in unary, binary, ternary, and other systems; applications in product development and in understanding behavior of ceramic materials. *Mr. Hummel*
504. SOLID STATE REACTIONS IN CERAMIC SYSTEMS (2) Thermodynamic, kinetic, and structural study of reactions and of equilibrium in ceramic systems. Prerequisites: Chem. 451, 452.
506. MECHANICAL PROPERTIES OF CERAMIC MATERIALS (2-3) Experimental stress-strain-time relations in elasticity, anelasticity, plasticity, and rupture; theory of strength and control. *Mr. Buessem*
507. THERMAL PROPERTIES OF CERAMIC MATERIALS (2-3) Heat capacity, heat of fusion, thermal conductivity, and thermal expansion in relation to macroscopic measurements and basic atomic concepts applied to ceramic materials.
508. DIELECTRIC AND MAGNETIC PROPERTIES OF CERAMIC MATERIALS (2-3) Preparation and properties of ceramic semiconductors, dielectrics and magnetic materials. *Mr. Buessem*
510. SEMINAR IN GLASS TECHNOLOGY (1-2 per term) Current developments in glass technology and related fields. *Mr. Rindone*
511. CHEMICAL ASPECTS OF THE CONSTITUTION OF GLASS (1-3 per term) Historical development, properties, and atomistic interpretation of changes of properties with compositions, temperature, and past history. *Mr. Weyl*
512. PHYSICAL ASPECTS OF THE CONSTITUTION OF GLASS (1-3) Atomic structure of glass, its relation to physical properties; rheology; glass as a liquid. *Mr. Brindley*
515. SPECIAL PROBLEMS IN CERAMIC TECHNOLOGY (1-6 per term) Advanced individual study on a problem in ceramics.

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\*Nonceramic majors may schedule selected parts of this course for credit in conjunction with the relevant Cer.T. 401, 415, 420, 430.



516. SELECTED TOPICS IN CERAMIC TECHNOLOGY (1-3 per term) Intensive group study of special topics.
517. RESEARCH INSTRUMENTS AND EQUIPMENT (2) Applications of fundamental laws and principles in research instruments; care, adjustment, and effective use of instruments and equipment (demonstrations).
530. (Min. 530) STRUCTURE, PROPERTIES, AND OCCURRENCE OF CLAY MINERALS (2-5) Structure analysis and identification of clay minerals; mineral transformation and behavior; occurrence, genesis, and petrography of fine-grained sediments.

*Messrs. Brindley, Bates, and Griffiths*

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in ceramic technology studies are listed under Mineral Sciences in Part II of this bulletin. The subject of color in glasses is treated in Min. 521.

## CHEMICAL ENGINEERING

MERRELL R. FENSKE, *Head of the Department*  
131 Chemical Engineering Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Fenske, Quiggle, and Rose; Associate Professors Braun, Carnahan, Hersh, Jones, Klaus, and McCormick; Assistant Professors Engel and Lloyd.

Course offerings or research facilities are available in the following areas: phase equilibria, thermodynamics, unit operations, unit processes, nuclear chemical engineering, petroleum technology, rheology, and lubrication. The facilities for instruction and research in chemical engineering and petroleum chemistry include those of the Petroleum Refining Laboratory.

To be admitted, a student should be a graduate of an accredited curriculum in chemical engineering or the equivalent. Graduates of other accredited engineering or physical science curriculums may be admitted but will be required to make up certain undergraduate deficiencies without graduate credit.

Thesis research work in petroleum chemistry, for the M.S. and Ph.D. degrees in chemistry, may be done in the Department of Chemical Engineering.

### CHEMICAL ENGINEERING (CH E)

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|------------------------------------------------|--------------------------------|
| 404. CHEMICAL PLANT DESIGN (3)                 | <i>Messrs. Engel and Lloyd</i> |
| 405. THERMODYNAMICS FOR CHEMICAL ENGINEERS (3) | <i>Mr. Snyder</i>              |
| 406. CHEMICAL ENGINEERING PROBLEMS (3)         | <i>Messrs. Engel and Lloyd</i> |
| 410. CHEMICAL ENGINEERING PRINCIPLES (3)       | <i>Mr. Carnahan</i>            |
| 411. CHEMICAL ENGINEERING PRINCIPLES (3)       | <i>Mr. Carnahan</i>            |
| 412. CHEMICAL ENGINEERING PRINCIPLES (3)       | <i>Mr. Carnahan</i>            |
| 420. CRYOGENIC ENGINEERING (3)                 | <i>Mr. Fritz</i>               |
| 422. PETROLEUM PROCESSES AND PRODUCTS (2)      |                                |
| 430. NUCLEAR CHEMICAL ENGINEERING (3)          | <i>Mr. Lloyd</i>               |
| 440. CHEMICAL ENGINEERING MATERIALS (3)        | <i>Mr. Engel</i>               |
| 445. CHEMICAL ENGINEERING RESEARCH (1-5)       |                                |
| 450. PROCESS DYNAMICS (3)                      |                                |
| 460. CHEMICAL ENGINEERING (4)                  |                                |

500. SEMINAR IN CHEMICAL ENGINEERING (1) Required of all graduate students.



## CHEMICAL ENGINEERING

505. SPECIAL TOPICS IN CHEMICAL ENGINEERING (2-12) Intensive study in the various specialized fields of chemical engineering.
510. ADVANCED HEAT TRANSFER I (3) Physical and chemical factors controlling the rate of heat transfer under conditions of steady flow.
511. ADVANCED HEAT TRANSFER II (3) Flow of heat under varying temperature conditions.
515. DISTILLATION (3) Commercial distillation, equilibrium diagrams, vapor composition, stills and rectifying and stripping columns.
516. ECONOMIC BALANCE (3) Problem work on the design of chemical engineering equipment from the economic standpoint.
518. CHEMICAL ENGINEERING DESIGN (3) Complicated examples are discussed and worked out. Several different unit operations will be combined for the design of a complete installation.
520. EXTRACTION PROCESSES (3) Equilibrium extraction data and phase contacting and settling related to equipment design.
521. MASS TRANSFER (3) Problem course on developments in diffusion, fluid dynamics, and phase equilibrium.
524. CHEMICAL ENGINEERING, APPLICATION OF THERMODYNAMICS (3) Elements of thermochemistry and thermodynamics of greatest importance in chemical engineering.
530. HEAT TRANSFER IN NUCLEAR REACTORS (3) Fluid flow, heat transfer, and design problems in nuclear reactor systems. *Mr. Lloyd*
535. APPLIED REACTION KINETICS (3) Basic principles of chemical kinetics, simultaneous heat and mass transfer, and prediction of rates; their application to reactor design.

## CHEMISTRY

THOMAS WARTIK, *Head of the Department*  
212 Whitmore Laboratory

*Degrees Conferred:* Ph.D., M.S., M.Ed.

*Graduate Faculty:* Professors Aston, Brickwedde, Deno, Dixon, Fleming, Fritz, Hutchison, Jordan, Miller, Noll, Oakwood, Quiggle, Seward, Skell, Smith, Sommer, Taft, Wartik, Willard, and Zook; Associate Professors Ascah, Goodman, Haas, Hayes, Hisatsune, Jones, Lampe, Schempf, Shamma, and Steele; Assistant Professors Currie, Gingerich, Lotz, Richey, and Schmulbach.

Students may specialize in analytical, inorganic, organic, physical, and petroleum chemistry. The general facilities are excellent, and the computer, cryogenic, microscopy, petroleum, radiochemical, and spectroscopy laboratories provide unusual research opportunities. Distinguished visiting scholars conduct informal discussions each Thursday at 1 p.m. at a departmental colloquium.

Students entering programs leading to the M.S. and Ph.D. degrees should have had training which includes at least one year's work in each of the following: general chemistry, analytical chemistry, organic chemistry, physical chemistry, and general physics. Mathematics through integral calculus is required, and a reading knowledge of at least one foreign language, preferably German, is expected.

The program leading to the M.Ed. degree is designed primarily for science teachers in secondary schools. Previous training should include a total of 18 credits in chemistry.

Prior to scheduling their first term program, new students will take examinations in the four areas of analytical, inorganic, organic, and physical chemistry. The information obtained from these tests will assist both the student and his adviser in making up a program best suited to the student's needs. These examinations are normally given just prior to the regular registration period.

CHEMISTRY (CHEM)

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|------------------------------------------------------------------------------------------------------------------|--------------|
| 400. CHEMICAL LITERATURE (1)                                                                                     | Mrs. Strauss |
| 401. SEMINAR (1)                                                                                                 |              |
| 405. NUCLEAR AND RADIOCHEMISTRY (3)                                                                              |              |
| 410. ADVANCED INORGANIC CHEMISTRY (4)                                                                            |              |
| 413. INORGANIC PREPARATIONS AND LABORATORY METHODS (2-5)                                                         |              |
| *421-422. ANALYTICAL CHEMISTRY (4 each)                                                                          |              |
| 426. INSTRUMENTAL METHODS OF ANALYSIS (3-5)                                                                      |              |
| 435. ORGANIC PREPARATIONS AND LABORATORY METHODS (3-5)                                                           |              |
| 437. QUALITATIVE ORGANIC ANALYSIS (3)                                                                            |              |
| 448. COLLOID CHEMISTRY (3)                                                                                       |              |
| *451-452. PHYSICAL CHEMISTRY (3 each)                                                                            |              |
| 453. ADVANCED PHYSICAL CHEMISTRY (3)                                                                             |              |
| 454. ADVANCED PHYSICAL CHEMISTRY (3)                                                                             |              |
| 455. PHYSICAL CHEMISTRY OF HIGH POLYMERS (3)                                                                     |              |
| *457-458. EXPERIMENTAL PHYSICAL CHEMISTRY (1 each)                                                               |              |
| 459. EXPERIMENTAL PHYSICAL CHEMISTRY (1)                                                                         |              |
| 470. CHEMICAL MICROSCOPY (3)                                                                                     | Miss Willard |
| 471. SPECIAL TOPICS IN CHEMICAL MICROSCOPY (2-6)                                                                 | Miss Willard |
| 472. QUANTITATIVE ORGANIC MICROANALYSIS (3)                                                                      | Mr. Fleming  |
| 474. QUANTITATIVE ORGANIC MICROANALYSIS (3)                                                                      | Mr. Fleming  |
| 477. CHEMICAL PHOTOMICROGRAPHY (3)                                                                               | Miss Willard |
| 489. INTRODUCTION TO CHEMICAL RESEARCH (1-10)                                                                    |              |
| †490. ORGANIC CHEMISTRY (5)                                                                                      |              |
| †491. ORGANIC CHEMISTRY (5)                                                                                      |              |
| †492a. ADVANCED GENERAL CHEMISTRY FOR TEACHERS (3)                                                               |              |
| †493. SELECTED TOPICS IN CHEMISTRY FOR TEACHERS (3)                                                              |              |
| †494. CHEMICAL DEMONSTRATIONS FOR TEACHERS (3)                                                                   |              |
| 500. SEMINAR IN INORGANIC CHEMISTRY (1 per term)                                                                 |              |
| 501. SEMINAR IN PHYSICAL CHEMISTRY (1 per term)                                                                  |              |
| 502. SEMINAR IN ORGANIC CHEMISTRY (1 per term)                                                                   |              |
| 503. SEMINAR IN ANALYTICAL CHEMISTRY (1 per term)                                                                |              |
| 516. SYSTEMATIC INORGANIC CHEMISTRY (3) Systematic treatment of inorganic chemistry in terms of modern concepts. |              |
| 517. CHEMISTRY OF THE LESS FAMILIAR ELEMENTS (3) Continuation of Chem. 516.                                      |              |
| 518. SPECIAL TOPICS IN INORGANIC CHEMISTRY (3 per term) Modern developments in specialized fields.               |              |

\*Graduate credit not allowed for students majoring in chemistry or chemical engineering.

†Candidates for the M.Ed. degree.



## CHEMISTRY

525. ANALYTICAL PROCESSES (3) Separative and determinative processes in analytical chemistry.
526. MODERN INSTRUMENTAL ANALYSIS (3)
527. SPECIAL TOPICS IN ANALYTICAL CHEMISTRY (2-12)
531. SPECIAL TOPICS IN ORGANIC CHEMISTRY (3-12)
532. ORGANIC NITROGEN COMPOUNDS (3) Chemistry, stereochemistry, and molecular structure of organic compounds containing nitrogen. *Mr. Aston*
534. THEORETICAL ORGANIC CHEMISTRY (3) Modern theories of structure; resonance; interpretation of physical properties; theory of rates; equilibrium properties. *Mr. Aston*
- 535-536. ORGANIC CHEMISTRY (3 each) Adapted to the needs of those doing research work in organic chemistry.
537. ORGANIC CHEMISTRY OF HIGH POLYMERS (3) High polymer theory and practice from the viewpoint of organic chemistry.
538. ORGANIC CHEMISTRY (3) Survey of organic chemistry arranged primarily for graduate students majoring in fields other than organic chemistry.
539. STEREOCHEMISTRY (3) Comprehensive treatment of the principles of stereochemistry as applied to organic compounds. *Mr. Oakwood*
540. EXPERIMENTAL METHODS OF PHYSICAL CHEMISTRY (3-5)
541. PHASE RULE (3) The phase rule and its applications.
542. COLLOIDS (3) The physics and chemistry of surfaces and their resulting colloid properties; methods of preparing colloids. *Mr. Smith*
544. CHEMICAL THERMODYNAMICS (3) Development of thermodynamic theory with special reference to common physical changes and chemical reactions. Prerequisite: Chem. 461.
545. CHEMICAL THERMODYNAMICS AND INTRODUCTORY STATISTICAL MECHANICS (3) Continuation of Chem. 544 including the calculation of thermodynamic properties from molecular and spectroscopic data. Prerequisite: Chem. 544.
546. QUANTUM CHEMISTRY (3) Calculation of electronic properties of atoms and molecules by wave mechanical methods including molecular orbital theory. Prerequisite: Chem. 565.
547. STATISTICAL MECHANICS (3) Properties of matter at equilibrium, developed on the basis of energy levels of molecules and statistical mechanical theory. Prerequisite: Chem. 565.
548. CATALYSIS (3) Theory of catalysis and its application to industry.
560. TOPICS IN PHYSICAL CHEMISTRY (3-12)
- 561-562. CHEMICAL PRINCIPLES (3 each) Mathematical treatment of the classical principles of chemistry; their application to problems. Required of all graduate students. Prerequisites: Chem. 452, Math. 44, Phys. 204. A course in organic chemistry is recommended.
563. CHEMICAL KINETICS (3) Theory and measurement of the rates of chemical reactions; the mechanism of chemical reactions.



564. CHEMICAL KINETICS (3) Continuation of Chem. 563 including theory and measurement of photochemical reactions.
565. ATOMIC AND MOLECULAR STRUCTURE (3) Introduction to modern theoretical chemistry: chemical bonds and molecular spectra.
567. ADVANCED THEORETICAL CHEMISTRY (3) Modern and current theories of the properties of chemical substances and their applications to chemical problems; the construction of chemical theory.
581. EXPERIMENTAL METHODS IN PETROLEUM CHEMISTRY (1-12)
582. TOPICS IN PETROLEUM CHEMISTRY (2-6)

## CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS

WINONA L. MORGAN, *Head of the Department*  
105E Home Economics South

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed. in the general field of Child Development and Family Relationships.

*Graduate Faculty:* Professors Britton, Harms, Morgan, and Smith; Associate Professors Broderick, de Lissovoy, and Siegel.

Students may specialize in the guidance and development of children, relationships among various members of the family, problems of all stages of the family cycle, nursery school education, education for home and family living in the schools, parental education, and work with children and families in community agencies.

The entering student should have had at least 6 credits in the physical and biological sciences, 12 in the social sciences (which must include a basic course in sociology and one in psychology), and 6 in child development and family relationships. Students who are otherwise qualified but who lack some of these credits may be admitted and permitted to make up the deficiency credits along with a graduate program.

### CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS (CD FR)

- |                                                                                                                                                                                                                                                 |                        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| 418. FAMILY RELATIONSHIPS (3)                                                                                                                                                                                                                   | <i>Mr. Broderick</i>   |
| 429. ADVANCED CHILD DEVELOPMENT (3)                                                                                                                                                                                                             | <i>Mr. de Lissovoy</i> |
| 430. OBSERVATION AND EXPERIENCE IN NURSERY SCHOOL (1-4)                                                                                                                                                                                         | <i>Miss Russell</i>    |
| 441. NURSERY SCHOOL ORGANIZATION (3)                                                                                                                                                                                                            | <i>Miss Russell</i>    |
| 445. (Psy. 445) DEVELOPMENT THROUGHOUT ADULTHOOD (3)                                                                                                                                                                                            | <i>Mr. Britton</i>     |
| 481. EDUCATIONAL METHODS WITH PRESCHOOL CHILDREN (3)                                                                                                                                                                                            | <i>Miss Russell</i>    |
| 500. NONTHESIS RESEARCH (1-6)                                                                                                                                                                                                                   |                        |
| 508. PARENTAL EDUCATION (3) Discussion and use of methods, experiences, and programs which can be used effectively to help parents in dealing with problems of parent-child relationships. Prerequisites: C.D.F.R. 429, 430. <i>Miss Morgan</i> |                        |
| 515. THE TEACHING OF CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS (3) Methods of selection and presentation of subject matter basic to understanding the development of children. <i>Miss Morgan</i>                                              |                        |
| 529. (Psy. 529) SEMINAR IN CHILD DEVELOPMENT (1-6) Readings and reports on recent findings in child development. Prerequisites: 6 credits in child                                                                                              |                        |

## CHILD DEVELOPMENT

development or 6 in educational or child psychology, plus 3 in statistics.

*Miss Harms*

530. PROBLEMS IN CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS (1-6) Problems involving individual research in library, laboratory, or field projects.

539. THEORIES OF CHILD DEVELOPMENT (3) Historical background of the major theories concerning child development and behavior and their application.

*Mrs. Siegel*

545. THE FAMILY IN ITS COMMUNITY (3) Cultural influences on family relationships; how the family orients its members to community living and group participation.

*Mr. Broderick*

546. SEMINAR IN FAMILY RELATIONSHIPS (1-6) Reading, reports, and discussion of recent research in relationship aspects of family living; particular attention to studies of roles, crises, and adjustments within the family setting.

*Mr. Broderick*

## CIVIL ENGINEERING and SANITARY ENGINEERING

BENJAMIN A. WHISLER, *Head of the Department of Civil Engineering*  
208 Sackett Building

*Degrees Conferred:* Civil—Ph.D., M.S., M.Eng.; Sanitary—M.S., M.Eng.

*Graduate Faculty:* Professors Kountz, Perez, Reen, Shulits, and Whisler; Associate Professors Moore, Nesbitt, and Underwood.

The entering student should be a graduate in civil engineering from an accredited college of engineering. Students may specialize in structures, hydraulics, transportation engineering, surveying, and sanitary engineering, or combinations of these, through courses offered both by the Department of Civil Engineering and by other departments of the University.

### CIVIL ENGINEERING (C E)

- 400. SEMINAR (1-3)
- 401. CIVIL ENGINEERING PROJECTS (2-12)
- 412. ADVANCED PHOTOGRAMMETRY (3)
- 421. HIGHWAYS AND STREETS (3)
- 423. HIGHWAY SAFETY AND TRAFFIC CONTROL (3)
- 431. CIVIL ENGINEERING CONSTRUCTION (3)
- 446. ADVANCED SOIL MECHANICS (3)
- 447. ADVANCED STRUCTURAL ANALYSIS (3)
- 448. ADVANCED STRUCTURAL DESIGN (3)
- 451. ADVANCED HYDROLOGY (3)
- 462. OPEN CHANNEL HYDRAULICS (3)
- 465. RIVER AND WATERWAYS ENGINEERING (3)
- 471. MUNICIPAL AND RURAL SANITATION (3)
- 472. TREATMENT PLANTS (3)

500. SEMINAR IN CIVIL ENGINEERING (1-6) Reports on researches and special topics. Course may be continued in subsequent terms.



521. TRANSPORT PLANNING AND DESIGN (2-6) Planning and design of transportation facilities; basic principles and engineering techniques applied to airways, highways, pipe lines, railways, waterways. Prerequisite or concurrent: C.E. 51 or 421.
522. TRANSPORT OPERATION AND MAINTENANCE (2-6) Engineering problems in operation, maintenance, and administration of airways, highways, pipe lines, railways, waterways. Prerequisite or concurrent: C.E. 51 or 421.
540. ADVANCED STRUCTURAL ANALYSIS (2-4) Geometry of flexure, deflections; analysis of continuous beams, rigid frames, arches; influence lines. Prerequisite: C.E. 46.
541. ADVANCED STRUCTURAL ANALYSIS (2-4) Truss deflection; trusses with redundant members, continuous trusses, framed arches; influence lines; secondary stresses; wind stresses; space framework; suspension bridges. Prerequisite: C.E. 46.
542. APPLIED SOIL MECHANICS (2-5) Soil classification by type of clay minerals and profile development; aerial photographic interpretation of soils and applications to site selection for dams, highways, and airports. Prerequisites: C.E. 412, 446.
543. STRUCTURAL ENGINEERING PROJECTS (3-10) Investigation or design projects in concrete, soil mechanics, photoelasticity, analysis, etc. Prerequisite or concurrent: C.E. 447, 448.
544. ADVANCED STRUCTURAL DESIGN (2-4) Plain and reinforced concrete design as applied to buildings, bridges, retaining walls, domes, tanks, and dams; prestressed concrete. Prerequisite: C.E. 448.
545. ADVANCED STRUCTURAL DESIGN (2-4) Structural steel design as applied to riveted and welded girders, trusses, rigid frames, wind connections; timber design. Prerequisite: C.E. 41.
547. ADVANCED STRUCTURAL THEORY (3-6) Prestressed concrete, arches, suspension bridges, concrete dams, thin shells, and other current topics. Prerequisite: C.E. 447.
550. ENGINEERING CONSTRUCTION (2-4) Construction methods applied to foundations, buildings, bridges, and other civil engineering construction work. Prerequisites: C.E. 41, 42.
551. HYDROLOGIC INVESTIGATIONS (2-8) Application of hydrologic principles and techniques to a specific project. Prerequisite: C.E. 451.
560. DIMENSIONAL ANALYSIS AND THEORY OF MODELS (3) Principles of dimensional analysis and similitude with engineering applications.
564. HYDRAULIC ENGINEERING DESIGN (2-8) Design and analysis of selected units of a typical hydraulic engineering project.
565. TRANSPORTATION OF SOLIDS BY FLUIDS (2-5) Fundamentals of the flow of solids in open and closed conduits; e.g., suspended load and bed load in rivers, slurries and pulp stocks in pipes.
571. WATER PURIFICATION AND SOFTENING (3) Current methods of softening, disinfecting, and conditioning water for municipal and industrial use. Prerequisite: C.E. 70.
572. SEWAGE TREATMENT (3) Modern methods of sewage treatment. Prerequisite: C.E. 70.
573. ADVANCED PROBLEMS IN SANITARY ENGINEERING (3-10) Investigations, analyses, and reports on current topics in sanitary engineering.



## CIVIL ENGINEERING

574. ANALYTICAL EVALUATIONS IN SANITARY ENGINEERING (3) Experiments illustrating current chemical and biochemical methods of water and waste treatment and analytical methods used in research and control.
575. ADVANCED INDUSTRIAL WASTE TREATMENT (3) Techniques of industrial waste treatment; attendant stream pollution and stream self-purification factors. Prerequisite: C.E. 472 or 572.
576. WATER TREATMENT PLANT DESIGN (1-6) Design of works for treatment of water for municipal and industrial use. Prerequisite: C.E. 71.
577. SEWAGE TREATMENT PLANT DESIGN (1-6) Design of works for treatment of sewage or industrial wastes. Prerequisite: C.E. 71.
578. INDUSTRIAL HYGIENE (3) Principles of control of industrial toxics and the protection of the worker and the community.
579. PUBLIC HEALTH ADMINISTRATION (3) Operation and duties of health departments at the various levels.

## CLINICAL SPEECH

EUGENE T. McDONALD, *Director of the Speech and Hearing Clinic*  
2S Sparks Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors McDonald and Siegenthaler; Associate Professors Berlin and Frick; Assistant Professor Raabe.

Students may specialize in either speech correction or audiology. Admission to study for the master's degree requires 27 semester hours in clinical speech and hearing, education, and psychology, including at least 9 credits in speech correction and/or audiology. Applicants for the M.S. degree must have had a course in statistics; applicants for the M.Ed. degree must have had student teaching. Applicants for the M.S. degree may count credits in speech science toward the required 27 hours.

### SPEECH EDUCATION (SP ED)

430. HEARING PROBLEMS AND THE TESTING OF HEARING (3)
434. AUDIOMETRY AND HEARING AIDS (3)
435. CLINICAL PRACTICE WITH THE HEARING HANDICAPPED (1-6)  
Unit A. *Audiologic Evaluation and the Selection of Hearing Aids* (1-4)  
Unit B. *Auditory Training and Speech Reading* (1-4)
436. INTRODUCTION TO SPEECH CORRECTION (3)
437. CLINICAL PRACTICE IN SPEECH CORRECTION (1-3)
440. SPEECH EDUCATION FOR THE CLASSROOM TEACHER (2-3)
441. CURRENT PROBLEMS IN SPEECH AND HEARING (1-6)
442. SPEECH PATHOLOGY (3)
443. METHODS IN AUDITORY TRAINING AND SPEECH READING (3)
445. THE PUBLIC SCHOOL SPEECH CORRECTION PROGRAM (3)
525. SEMINAR IN CLINICAL SPEECH PATHOLOGY (3-9) Prerequisites: Sp.Ed. 436, 442.  
Unit A. *Cleft Palate*  
Unit B. *Cerebral Palsy*  
Unit C. *Aphasia*

530. SEMINAR IN AUDIOLOGY (2-4) Review of theories of hearing and review of related physiological and psychological researches. Prerequisite: Sp.Ed. 434.
537. ADVANCED CLINICAL PRACTICE IN SPEECH CORRECTION (1-9) Prerequisites: Sp.Ed. 437, 442.  
*Unit A. Diagnostic Procedures (1-3)*  
*Unit B. Treatment Procedures (1-6)*
540. ARTICULATION DISABILITIES (3) Speech-sound production disorders in children and adults; methods of examination, diagnosis, and treatment. Prerequisites: Sp.Ed. 437, 442.
541. THE VOICE AND ITS DISORDERS (3) Physical, physiological, and psychological bases of voice production; causes, nature, and symptoms of its disorders; current clinical methods in voice improvement. Prerequisites: Sp.Ed. 437, 442.
542. STUTTERING AND ALLIED DISORDERS (3) Modern theories of causes of disorders of rhythm; methods of examination, diagnosis, and treatment. Prerequisites: Sp.Ed. 437, 442.
543. DIAGNOSTIC PROCEDURES IN CLINICAL SPEECH (3) Clinical instrumentation; case history taking; examination procedures and materials used in diagnosing speech disabilities; interpretation of findings; report preparation. Prerequisites: Sp.Ed. 437, 442.

## CLOTHING AND TEXTILES

RUTH W. AYRES, *Head of the Department*  
 120A Home Economics Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professor Ayres; Associate Professors Densmore and Gates.

Work may be taken with major emphasis in the textile area, which stresses the background natural sciences, or in the clothing area, which stresses the background social sciences. Candidates are accepted who have a strong foundation and a good record in any of the following: home economics, chemistry, sociology, economics, or psychology.

### CLOTHING AND TEXTILES (CL TX)

- |                                                                                                                                          |                      |
|------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| 400. SPECIAL PROBLEMS IN CLOTHING AND TEXTILES (1-6)                                                                                     |                      |
| 402. FUNDAMENTAL PRINCIPLES OF TAILORING CONSTRUCTION (3)                                                                                | <i>Mrs. Larson</i>   |
| 403. CREATIVE PATTERN MAKING (3)                                                                                                         | <i>Mrs. Larson</i>   |
| 404. DRAPING (3)                                                                                                                         | <i>Mrs. Larson</i>   |
| 406. FASHION PROMOTION (3)                                                                                                               |                      |
| 407. THE TEXTILE AND CLOTHING INDUSTRY (3)                                                                                               | <i>Miss Ayres</i>    |
| 408. INTERMEDIATE TEXTILES (3)                                                                                                           | <i>Miss Densmore</i> |
| 410. CLOTHING FOR THE FAMILY (3)                                                                                                         |                      |
| 411. ADVANCED CLOTHING CONSTRUCTION (3)                                                                                                  | <i>Mrs. Larson</i>   |
| 413. TEXTILE TECHNOLOGY (3)                                                                                                              | <i>Miss Densmore</i> |
|                                                                                                                                          |                      |
| 500. NONTHESIS RESEARCH (1-6)                                                                                                            |                      |
|                                                                                                                                          |                      |
| 503. ADVANCED PATTERN DEVELOPMENT (3) Analysis of advanced pattern designing principles to give students facility in original designing. |                      |

## CLOTHING AND TEXTILES

504. ADVANCED DRAPING (3) Analysis of principles and techniques as a basis for creation of original designs; survey of literature in dress design.
505. CLOTHING INSTRUCTIONAL MATERIALS (3) Development of instructional materials and techniques based on needs of diverse groups.
506. THE FASHION WORLD (3) *Miss Gates*
507. PROBLEMS IN RELATION TO CLOTHING CONSUMPTION (3) Problems connected with manufacture and consumption of clothing; interrelation of textile and clothing trades with other industries. *Miss Ayres*
508. SPECIAL PROBLEMS IN CLOTHING AND TEXTILES (1-6) Individual directed study, investigation, and practice in selected phases of textiles and clothing.
509. SEMINAR IN CLOTHING AND TEXTILES (1-6)
510. RESEARCH METHODS AND EVALUATION IN CLOTHING AND TEXTILES (1-6) *Misses Densmore and Gates*
511. CURRENT DEVELOPMENTS IN CLOTHING AND TEXTILES (1-6)
512. HISTORY OF CLOTHING AND CLOTHING CONSTRUCTION (3) *Miss Gates*
513. ADVANCED TEXTILE TECHNOLOGY (6) *Miss Densmore*

## COMPARATIVE LITERATURE

PHILIP A. SHELLEY  
*Chairman of the Committee on Comparative Literature*  
229 Sparks Building

*Degrees Conferred: Ph.D., M.A.*

Programs are arranged through a meaningful selection of courses offered by the several departments of languages and literatures, both ancient and modern, as well as of those specifically in the category of comparative literature. More than a minimum knowledge of foreign languages is required.

### COMPARATIVE LITERATURE (C LIT)

400. COMPARATIVE METHOD IN LITERARY STUDIES (3)
443. (Ger. 443) LITERARY RELATIONS OF GERMANY WITH ENGLAND AND AMERICA (3-9) *Mr. Shelley*
470. OLD MASTERS OF THE MODERN NOVEL (3) *Mr. Morse*
480. INTRODUCTION TO FOLKLORE (3) *Mr. Bayard*
500. SEMINAR IN COMPARATIVE LITERATURE (3-6)
508. NORSE AND GAELIC SAGAS (3) Medieval Irish and Scandinavian prose tales surveyed and compared with respect to backgrounds, development, themes, and characteristics. *Mr. Bayard*
570. FORCES IN CONTEMPORARY EUROPEAN LITERATURE (3) The intellectual currents that have influenced European writers of the mid-twentieth century: Beckett, Boll, Robbe-Grillet, and others. *Mr. Morse*



## COUNSELING IN EDUCATION

GEORGE R. HUDSON

*In Charge of Graduate Programs in Counseling in Education*  
418 McAllister Hall

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professor Wellington; Associate Professor Hudson; Assistant Professor Hylbert.

Professional preparation programs are offered at the master's level for elementary or secondary school counselors, home and school visitors, college counselors, and rehabilitation counselors. Doctoral programs prepare for pupil personnel administration, college student personnel administration, or supervision of rehabilitation.

All candidates for graduate degrees in counseling in education must present for admission at least 27 undergraduate credits in economics, education, psychology, sociology, and physiology or anatomy, with some credits in at least three of these areas.

Prospective school counselors and home and school visitors must have a teaching certificate to enter the program and must have two years of teaching experience before receiving a degree. Those wishing to become college counselors must have a year of college teaching or college personnel experience to qualify for a degree. Since graduate students in rehabilitation counseling combine a supervised internship with professional training, their master's degree program is correspondingly lengthened.

A candidate for either a Ph.D. or a D.Ed. degree in counseling in education must spend at least three consecutive terms in residence after earning the master's degree. Students may be employed during this required residence period not to exceed one-half-time, thereby necessitating an extension of their residence requirements accordingly.

The following courses are used in the graduate programs of majors in counseling in education: Ed. Ser. 403, 404, 408, 409, 490, 494, 503, 505, 506, 507, 508, 509, 511, 512, 522, 545, 551, 598, 600 or 610; Psy. 414, 418, 426, 436, 437, 445, 450, 482, 502, 535; Soc. 403, 426, 427, 450; Pl.Sc. 433; Anthy. 402; Econ. 404.

## DAIRY SCIENCE

DONALD V. JOSEPHSON, *Head of the Department*  
105 Borland Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Almquist, Doan, Josephson, and Patton; Associate Professors Flipse, Kesler, and Watrous; Assistant Professors Keeney and O'Dell.

Students may specialize in dairy products manufacture, chemistry of milk and dairy products, dairy cattle nutrition, dairy cattle management, and physiology of reproduction. The minor program is generally taken in agricultural and biological chemistry, bacteriology, zoology, or agricultural economics.

Prerequisite to graduate work is the completion of an undergraduate curriculum in dairy science or a related science area. The undergraduate program must include college algebra and general physics. Students may be admitted with limited deficiency but are required to make up undergraduate deficiency work without degree credit.

## DAIRY SCIENCE

### DAIRY SCIENCE (D SC)

418. DAIRY SURVEY (1) *Mr. Josephson*  
421. TECHNICAL CONTROL PROBLEMS (1-10) *Mr. Doan and Staff*  
427. MILK SECRETION (3) *Mr. Kesler*  
428. DAIRY PRODUCTION PROBLEMS (1-6) *Mr. Kesler and Staff*  
431. PHYSIOLOGY OF REPRODUCTION IN FARM ANIMALS (3) *Mr. Almquist*
501. BUTTER AND CHEESE (1-6) Manufacture and handling of butter and cheese.  
Prerequisites: D.Sc. 10, 23, Bact. 8, A.B.Ch. 403. *Mr. Watrous*
502. CONDENSED MILK AND MILK POWDER (1-6) Condensing and drying of milk.  
Prerequisites: D.Sc. 10, 26, Bact. 8, A.B.Ch. 403. *Mr. Doan*
503. PUBLIC MILK PROBLEMS (1-6) Handling milk in modern plants. Prerequisites: D.Sc. 11, Bact. 8, A.B.Ch. 403. *Mr. Doan*
504. ICE CREAM MANUFACTURE (1-6) Manufacture of ice cream, ices, and other frozen milk products. Prerequisites: D.Sc. 11, Bact. 8, A.B.Ch. 403. *Mr. Keeney*
505. DAIRY PLANT ECONOMICS (1-6) Economic factors involved in creamery operation and management. Prerequisites: D.Sc. 7, 11. *Mr. Watrous*
507. DAIRY CATTLE MANAGEMENT (1-6) Management of dairy cattle. Prerequisite: D.Sc. 27. *Mr. Kesler and Staff*
508. DAIRY SEMINAR (1-6) Preparation and presentation of a paper on an assigned subject. *Mr. Patton and Staff*
509. TESTING DAIRY PRODUCTS (1-6) Constituents of dairy products. Prerequisites: D.Sc. 11, Bact. 8, A.B.Ch. 403. *Mr. O'Dell*
510. DAIRY CATTLE FEEDING (1-6) Application of fundamental research in animal nutrition to the feeding of dairy cattle. Prerequisites: D.Sc. 1, 29. *Mr. Kesler*
511. DAIRY CATTLE NUTRITION (1-6) Nutritional requirements of dairy cattle. Prerequisite: A.Ntr. 401. *Mr. Kesler*
512. ADVANCED STUDIES IN MILK SECRETION (1-6) Physiology of milk secretion. Prerequisite: D.Sc. 427. *Mr. Kesler*
513. DAIRY CATTLE SELECTION (1-6) Breed history, pedigrees, selection, and judging of dairy cattle. Prerequisites: D.Sc. 1, 30.
515. ADVANCED PHYSIOLOGY OF REPRODUCTION IN FARM ANIMALS (1-6) *Mr. Almquist*
516. ARTIFICIAL BREEDING OF FARM ANIMALS (1-6) Prerequisite: D.Sc. 431. *Mr. Almquist*
517. DAIRY SCIENCE LITERATURE (1-6) Review and reporting of dairy literature. *Mr. Josephson and Staff*
521. DAIRY RADIOPHYSIOLOGY (3) Metabolism and physiology of radioactive compounds; their use as tracers in animal physiology and the effects of radiation on metabolic processes. Prerequisite: Chem. 405.
522. RESEARCH PROCEDURES IN DAIRY TECHNOLOGY (3) Research problems and methods in dairy technology with major emphasis on dairy chemistry. Prerequisite: A.B.Ch. 403. *Mr. Patton*

## EARTH SCIENCES

HANS NEUBERGER

*Chairman of the Committee on Earth Sciences*  
322 Mineral Industries Building

*Degree Conferred:* M.Ed.

This program is designed to meet the needs of science teachers in secondary schools. The fields of study are astronomy, geography, geology, meteorology, mineralogy, and soils.

The program prepares candidates to teach at least one field of the earth sciences, familiarizes them with at least two additional earth science subjects, and at the same time enables them to increase their competence in the physical sciences, the biological sciences, and mathematics.

The student selects one of the earth sciences as an area of concentration, takes at least 12 credits in it, and is required to write a term paper in that area. An additional 12 credits must be taken in at least two other fields of earth sciences, or in two earth science fields plus two courses selected from the biological sciences, chemistry, mathematics, or physics. Furthermore, 6 credits in educational foundations are required as a minor.

## ECONOMICS

MONROE NEWMAN, *Head of the Department*  
124 Boucke Building

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Professors Cutler, Hench, Hexner, Kaufman, Mason, Newman, Reede, Saylor, and Stout; Associate Professors Kautz, Klein, Mares, Myers, and Sauerlender; Assistant Professors Iwand and Prybyla.

Opportunities are available for concentration in business statistics, economic theory, labor, international economics, government economic policy, money, credit, and public finance.

To enter graduate work in economics a student should have completed 6 credits in economic principles, 9 in the social sciences, and either 3 in statistics or 6 in mathematics.

## BUSINESS STATISTICS (B S)

500. SEMINAR IN BUSINESS STATISTICS (3-6)

501. ADVANCED BUSINESS STATISTICS (3)

## ECONOMICS (ECON)

400. HISTORY OF ECONOMIC THOUGHT (3)

404. ECONOMIC FRAMEWORK OF MODERN SOCIETY (3)

405. ADVANCED ECONOMIC ANALYSIS (3)

406. ECONOMIC GROWTH AND DEVELOPMENT (3)

412. ECONOMICS OF COLLECTIVE BARGAINING (3)

415. SOCIAL INSURANCE (3)

418. ECONOMICS OF WAGES AND EMPLOYMENT (3)



## ECONOMICS

- 419. CASE STUDIES IN LABOR-MANAGEMENT RELATIONS (3)
- 423. STATE AND LOCAL TAXATION (3)
- 425. THE MONEY MARKETS (3)
- 428. INCOME AND EMPLOYMENT THEORY (3)
- 429. FEDERAL FINANCES (3)
- 433. INTERNATIONAL MONETARY ECONOMICS (3)
- 442. MONOPOLY, COMPETITION, AND THEIR REGULATION (3)
- 450. THE BUSINESS CYCLE (3)
- 451. ADVANCED MONEY, BANKING, AND FISCAL POLICY (3)
- 480. MATHEMATICAL ECONOMICS (3)
- 490. MEASUREMENT OF THE ECONOMY (3)
- 499. FOREIGN STUDY IN ECONOMICS (2-6)
  
- 500. ECONOMICS SEMINAR (3-6)
- 501. RESEARCH METHODS IN ECONOMICS (3-6)
- 506. PROBLEMS IN ECONOMICS (3-6) Planned individual projects involving library, laboratory, or field work.
- 507. SEMINAR IN INTERNATIONAL ECONOMICS: THEORY AND POLICY (3-6)
- 508. SEMINAR IN MONEY, CREDIT, AND PUBLIC FINANCE (3-6) Prerequisite: Econ. 451.
- 510. ECONOMETRICS (3) Statistical estimation in mathematically formulated economic relationships.
- 511. SEMINAR IN INDUSTRIAL DISPUTES (3) Prerequisites: Econ. 14, 315.
- 512. WAGES (3)
- 513. DEVELOPMENT OF ECONOMIC DOCTRINES (3-6) Prerequisite: Econ. 405.
- 515. LABOR SEMINAR (3)
- 522. ADVANCED ECONOMIC THEORY (3-6) Theory of price and income determination. Prerequisite: Econ. 405.

## EDUCATIONAL ADMINISTRATION

WALTER J. DELACY

*In Charge of Graduate Programs in Educational Administration*  
110 Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Bixby, Davison, DeLacy, McGarey, Miller, and Remaley; Associate Professors Bosch and McAulay; Assistant Professor Willower.

Professional preparation programs are offered at the master's level for elementary and secondary school principals and supervisors. Doctoral programs prepare for positions of supervising principal, assistant superintendent, and superintendent of schools.

Requirements for admission to a graduate program in educational administration include 18 approved undergraduate credits in education and psychology. Applicants

## EDUCATIONAL SERVICES

for admission to the master's degree program are required to have had one year of teaching experience, or to be currently engaged in teaching. Two years of teaching experience are required for admission to the doctoral program.

While candidates are required to specialize in a field of professional education, they are also encouraged to acquire a general education in the social sciences, the behavioral sciences, and the humanistic foundations.

The following courses in educational administration are listed under the offerings of the Department of Educational Services: Ed.Ser. 480 and 565 to 582 inclusive. Additional courses may be selected from other areas and departments to meet the student's needs, including certification requirements.

**DEPARTMENT OF EDUCATIONAL SERVICES**—The Department of Educational Services (Franklin A. Miller, Head) offers graduate programs in counseling in education, clinical speech, educational administration, and higher education. It also offers a number of course sequences which are not graduate majors. The following Educational Services courses carry graduate credit and, with the approval of the student's adviser, may be applied toward the requirements for an advanced degree in any major field:

Adult Education	460-462
Counseling in Education	403-409, 503-513
Educational Administration	480, 565-582
Higher Education	545-555
History and Philosophy of Education	415-424, 516-523
Instructional Materials	435-445, 535-541
Research, Seminars, and Projects	596-599
Safety Education	450-452
Special Education	425-431, 525-529
Testing and Measurements	490-494, 590-595

### EDUCATIONAL SERVICES (ED SER)

- 403. GUIDANCE PRINCIPLES AND PRACTICES (3)
- 404. TEACHING AND GROUP GUIDANCE ABOUT OCCUPATIONS (3)
- 408. INTRODUCTION TO VOCATIONAL REHABILITATION (3)
- 409. MEDICAL INFORMATION FOR COUNSELORS (3)
- 415. CHARACTER EDUCATION (2-3)
- 417. PHILOSOPHIC BASIS OF EDUCATION (3)
- 418. HISTORY OF EDUCATION IN THE UNITED STATES (2-3)
- 420. HISTORY OF MODERN EUROPEAN EDUCATION (3)
- 425. EDUCATION OF EXCEPTIONAL CHILDREN (2-3)
- 427. EDUCATION OF THE MENTALLY RETARDED (2-3)
- 429. EDUCATION OF THE MENTALLY GIFTED CHILD (1-3)
- 430. PRACTICUM IN THE EDUCATION OF ATYPICAL CHILDREN (1-8)
- 431. ATYPICAL CHILDREN AND EDUCATIONAL ADJUSTMENTS (3)
- 435. VISUAL AND OTHER SENSORY AIDS FOR TEACHERS (1-3)
- 436. PREPARATION OF EDUCATIONAL STILL PICTURES (2-3)
- 437. SCRIPTING AND SHOOTING EDUCATIONAL MOTION PICTURES (2-3)
- 438. EDITING AND SOUND RECORDING IN THE PRODUCTION OF EDUCATIONAL MOTION PICTURES (2-3)
- 441. ORGANIZATION AND ADMINISTRATION OF VISUAL-SENSORY AIDS PROGRAMS (1-3)
- 442. MOTION PICTURES IN EDUCATION (2-3)
- 443. RADIO AND TELEVISION IN EDUCATION (3)
- 444. STILL PICTURES (1-2)

## EDUCATIONAL SERVICES

- 445. ADVANCED AUDIO-VISUAL EQUIPMENT (3)
- 450. VISUAL AND OTHER AIDS IN SAFETY EDUCATION (3)
- 451. TEACHING TRAFFIC SAFETY AND AUTOMOBILE OPERATION (3)
- 452. ORGANIZATION AND SUPERVISION IN SAFETY EDUCATION (3)
- 460. HISTORY, PHILOSOPHY, AND GENERAL ORGANIZATION AND ADMINISTRATION OF ADULT EDUCATION (1)
- 461. ORGANIZATION, TYPES, AND METHODS OF ADULT EDUCATION AND PARENTAL EDUCATION (1)
- 462. METHODS IN ADULT EDUCATION AND LEADERSHIP OF DISCUSSION GROUPS (1)
- 480. EDUCATIONAL ADMINISTRATION (2-3)
- 490. EDUCATIONAL STATISTICS AND MEASUREMENTS (2-3)
- 494. EDUCATIONAL TESTING PROGRAMS (3)
  
- 503. GUIDANCE SERVICES IN ELEMENTARY EDUCATION (3) Guidance services to elementary school students; guidance opportunities for elementary teachers and principals.
- 505. OCCUPATIONAL AND EDUCATIONAL INFORMATION (3) Occupational information for guidance purposes; educational information related to vocational choice and preparation. Prerequisite: Ed.Ser. 403.
- 506. STUDENT ANALYSIS PROCEDURES FOR COUNSELORS (3) Collection and use of data basic to the counselor's understanding of individuals; the counseling interview and techniques other than testing.
- 507. SUPERVISED EXPERIENCE IN STUDENT COUNSELING (3) Practice in the application of guidance principles and methods to cases counseled under supervision; case conferences; seminar in guidance techniques. Prerequisite: Ed.Ser. 403.
- 508. ORGANIZATION AND ADMINISTRATION OF GUIDANCE PROGRAMS (3) Principles, organization, personnel, functions, integration with school programs, evaluation. Prerequisite: Ed.Ser. 403.
- 509. CONTRIBUTIONS OF PROFESSIONAL PERSONNEL TO VOCATIONAL REHABILITATION (3) Contributions of medical, social, psychological, and other specialists through the team approach; professional ethics, medical problems. Prerequisites: Ed.Ser. 403, 408.
- 511. SUPERVISED PRACTICUM IN REHABILITATION COUNSELING (1-6) Application of principles and techniques of rehabilitation counseling to cases involving handicapped individuals. Prerequisites: Ed.Ser. 403, 408.
- 512. PROFESSIONAL EXPERIENCE IN REHABILITATION COUNSELING (1-6) Supervised internship with responsibility for a regular case load. Prerequisite: Ed.Ser. 511.
- 513. SUPERVISION OF GUIDANCE WORKERS (3) Practical experience in supervising and evaluating work of counselors. Prerequisite: Ed.Ser. 507.
- 516. SOCIAL FOUNDATIONS OF EDUCATION (2-4) Social institutions and functions and their relationship to public education; analysis of the functions assignable to formal education. Prerequisites: El.Ed. 311 or Sec.Ed. 331; Psy. 14.
- 517. ADVANCED PHILOSOPHY OF EDUCATION (2-4) Analysis of educational policy and practice for philosophic consistency and commitment; philosophical implication in selected educational literature.
- 518. EVOLUTION OF EDUCATIONAL THOUGHT (2-3) Rise of formal educational philosophy from Plato to John Dewey; preliminary reference to Chinese, Hindu, Chaldean, Persian, Hebrew, and Egyptian theories.



## EDUCATIONAL SERVICES

521. **EDUCATION IN THE LATIN-AMERICAN COUNTRIES (2-3)** Recent educational progress in Central and South America, with special reference to Mexico, Cuba, Puerto Rico, Brazil, Chile, and Argentina.
522. **COMPARATIVE EUROPEAN EDUCATION (3)** Educational policies and practices in school systems in western and central European nations. Prerequisite: Psy. 14.
523. **EDUCATION IN RUSSIA, ASIA, AND THE MIDDLE EAST (2-3)** Current educational activities in Soviet Russia and other eastern European countries; the Middle East, North Africa, and the Far East.
525. **INTERNSHIP IN SPECIAL EDUCATION SUPERVISION (3-6)** Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
527. **PROBLEMS IN THE EDUCATION OF THE MENTALLY RETARDED (1-4)** Study of existing curriculums, instructional practices, educational programs; experimentation in curriculum building and materials construction. Prerequisites: teaching experience; Ed.Ser. 425 or 577, and Ed.Ser. 427.
529. **PROBLEMS IN THE EDUCATION OF THE MENTALLY GIFTED (1-4)** Analysis of educational needs of mentally gifted; curriculum construction and curricular materials. Prerequisites: teaching experience; Ed.Ser. 425 or 577, and Ed.Ser. 429.
535. **SEMINAR IN CURRICULUM MATERIALS AND THEIR UTILIZATION (3)** Advanced detailed analysis of mass communication media; relationships among these and educational objectives, individual differences in learners, and ideas to be communicated. Prerequisites: Ed.Ser. 435, Sec.Ed. 585, 6 credits in educational psychology.
540. **INTERNSHIP IN AUDIO-VISUAL EDUCATION (3-6)** Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
541. **LABORATORY IN ORGANIZATIONAL ASPECTS OF MATERIALS OF INSTRUCTION (1-3)** Organizing, storing, circulating, and maintaining instructional material in an instructional materials library. Prerequisites: Ed.Ser. 435, Sec.Ed. 585. Conference 1 hour, alternate weeks by appointment.
545. **HIGHER EDUCATION IN THE UNITED STATES (2-3)** Historical perspective and current status; development of functions and structures; issues in curriculum, admissions, government, administration, and finance.
546. **THE PRINCIPLES OF COLLEGE TEACHING (2-3)** Principles involved in teaching at the college level; effective use of teaching aids; criteria used in evaluation.
547. **INTERNSHIP IN COLLEGE TEACHING (3-6)** Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
548. **CURRICULUMS IN HIGHER EDUCATION (2-3)** Various types of curriculums and philosophies underlying them; ways in which curriculums are developed; elective versus required courses; evaluation of achievement.
549. **COMMUNITY JUNIOR COLLEGE AND THE TECHNICAL INSTITUTE (2-3)** Distinctive contributions to meeting the need for post-secondary education; development, functions, curriculum and instruction, government, administration and finance.
550. **THE PROFESSIONAL EDUCATION OF TEACHERS (3)** Development and present status of teacher education; objectives and standards; selection and guidance of students; personnel problems in relation to staff. Prerequisite: 6 credits in advanced courses in education and a course in educational psychology.

## EDUCATIONAL SERVICES

551. STUDENT PERSONNEL PROGRAMS AT THE COLLEGE LEVEL (2-3) Student personnel services in higher education; organization of student advisory programs; use of personnel data; co-curricular activities; student welfare.
552. ADMINISTRATION IN HIGHER EDUCATION (2-3) Philosophy of administration; principles of scientific management and their application in colleges and universities; case studies of administrative problems. Prerequisite: courses or experience in higher education.
555. SEMINAR IN COLLEGIATE EDUCATION (1-6) Special topics in higher education. Prerequisite: courses or experience in higher education.
565. PRINCIPLES OF SCHOOL SUPERVISION (2-3) Organization of supervision; planning the supervisory program; developing standards of teaching and learning; improvement of learning through tests and teacher rating. Prerequisites: 18 credits in education and 3 years' teaching experience.
566. THE ELEMENTARY SCHOOL PRINCIPAL AS SUPERVISOR (2-3)
567. THE SECONDARY SCHOOL PRINCIPAL AS SUPERVISOR (2-3) Improvement of instruction; improvement of teachers in service; evaluation of teaching procedures; methods of supervision; selection and use of textbooks. Prerequisite: three years' teaching experience.
568. THE ELEMENTARY SCHOOL PRINCIPAL AS ADMINISTRATOR (2-3) Duties of the elementary school principal in organizing and administering his school.
569. THE SECONDARY SCHOOL PRINCIPAL AS ADMINISTRATOR (2-4) Problems of schedule making, teachers' meetings, curriculum making and revision, organization of extracurricular and guidance programs. Prerequisite: teaching experience.
570. ADMINISTRATION AND SUPERVISION IN BUSINESS EDUCATION (3) Work of administrators, supervisors, and others responsible for improvement of instruction in business education; use of vocational testing; job analysis. Prerequisite: 6 credits in secondary education.
571. THE EDUCATIONAL PLANT (2-3) School plant needs in terms of school population and curriculums; the building survey, developing a plant program, the building site, plant utilization, operation and maintenance, heating and ventilation, equipment, school building costs and finance. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
572. PUBLIC RELATIONS FOR SCHOOL ADMINISTRATORS (2-3) Utilization of public participation in the formulation of school policies; relation of the school staff to the public and techniques for informing the public about what schools can do. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
573. PUBLIC SCHOOL FINANCE (2-3) Financing of public education in relation to organization and control; the conceptual basis for local financial administration; taxation, state and federal aid, school revenue, and money management. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
574. STATE AND NATIONAL EDUCATION PROGRAMS (2-3) Existing state and federal functions and relations to education; proposed programs. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience, and previous work in school administration.
575. ADMINISTRATION OF ADULT EDUCATION IN THE PUBLIC SCHOOLS (3) The organization of a program of adult education; its legal status, finances, selection of teachers, learning personnel, housing, and other administrative problems connected with adult education. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.



## EDUCATIONAL SERVICES

576. **LEGAL ASPECTS OF SCHOOL ADMINISTRATION (3)** Legal bases for the organization and administration of school districts and schools; the powers, rights, privileges, and responsibilities of school corporations, school boards, administrators, and personnel; the law and fiscal policies; the course of study, textbooks; contracts; taxes; torts; records; agents; and the judicial decisions involved. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
577. **THE ADMINISTRATION OF PUBLIC SCHOOL EDUCATION FOR ATYPICAL CHILDREN (2-3)** Problems connected with the instituting and organizing of classes for atypical children; the legal phases, finances, teaching personnel, pupil personnel, housing, equipment, courses of study, curriculum, etc. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
578. **DYNAMIC FACTORS IN SCHOOL ADMINISTRATION (2-3)** Factors which make for the improvement of public schools; influences with which administrators may work to improve the schools in their local situations; subsection of data on individual administrative situations to scientific check. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
579. **PUBLIC SCHOOL BUSINESS ADMINISTRATION (2-3)** Business management applied to school management problems; budgeting, accounting, purchasing, insurance, school equipment, cafeteria management; transportation, salaries, personnel management, and auxiliary and co-ordinate agencies. Prerequisites: Ed.Ser. 480 or teaching or administrative or supervisory experience; Ed.Ser. 573.
580. **SEMINAR IN SCHOOL ADMINISTRATION (1-6)** Efficiency in supervision, methods of diagnosis and evaluation of teaching and learning procedure, improving instruction, maintaining teacher morale, stimulating co-operative work. Prerequisites: Ed.Ser. 480, 6 credits in educational administration.
581. **EDUCATIONAL SURVEY TECHNIQUES (2-3)** Methods for appraisal of an educational program; planning for expansion, consolidation, or reduction of educational offerings. Prerequisites: Ed.Ser. 480, 6 credits in educational administration.
582. **INTERNSHIP IN ADMINISTRATION AND SUPERVISION (1-6)** Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
590. **ADVANCED EDUCATIONAL STATISTICS (2-4)** Appropriate measures and devices for experimental research in education including correlation measures, curve fitting, and analysis of variance. Prerequisite: 12 credits of graduate work in education including Ed.Ser. 490 or Psy. 415.
595. **INTRODUCTION TO THE ADVANCED STUDY OF EDUCATION (1-3)** Methods of educational research; criticism of studies and theses in education; initiating research projects; summarizing results of research. Prerequisite: Ed.Ser. 490 or Psy. 415.
596. **SEMINAR IN EDUCATION (1-3)** Conferences and discussions designed to meet the need for special study of particular fields in education. Prerequisite: 12 credits of graduate work in education.
597. **WORKSHOP IN CURRENT EDUCATIONAL PROBLEMS (1-6)** For administrators, supervisors, experienced elementary and secondary teachers, guidance workers; administrative, supervisory, and instructional problems involved in an emerging educational program. Prerequisite: 12 credits of graduate work in education.
598. **PROBLEMS, PROJECTS, AND AREA STUDIES IN EDUCATION (1-6)** Independent work in the study of topics in education or the development of new curriculums, materials, or procedures for teaching. Prerequisites: 12 credits of graduate work in education and approval of the department head.



## EDUCATIONAL SERVICES

599. INTERNSHIP IN PUBLIC SCHOOL RESEARCH (3-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.

## ELECTRICAL ENGINEERING

ARTHUR H. WAYNICK, *Head of the Department*  
105 Electrical Engineering Building

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Professors Holt, Tarpley, Volz, and Waynick; Associate Professors Atwater, Bowhill, Marsh, Pearson, Ross, Schmerling, and Shields; Assistant Professors Ferraro, Nisbet, and Somayajulu.

Course offerings and research facilities are available in the following areas: information theory, microwave theory and techniques, networks, computers (including digital, analog, and network analyzer), control, power conversion, servomechanisms, tubes and transistors, dynamical machine analysis, power dispatching, relay protection, and wave propagation.

The entering student must hold a bachelor's degree in engineering or science and have satisfactorily completed undergraduate course work in electrical circuits, machinery, and electronics.

### ELECTRICAL ENGINEERING (E E)

421a,b,c,d. ELECTRICAL ENGINEERING PROBLEMS (2-12)

425. SYMMETRICAL COMPONENTS (3)

426. TRANSISTORS (3)

428. SERVOMECHANISMS (3)

432. ULTRA-HIGH-FREQUENCY TECHNIQUES (3)

435. ENGINEERING ANALYSIS (3)

438. ELECTROMAGNETIC THEORY AND RADIATING SYSTEMS (3)

439. PULSE TECHNIQUES (3)

441. ACTIVE CIRCUITS (3)

450. ELECTRICAL NETWORK THEORY (3)

461. FUNDAMENTALS OF POWER SYSTEM STABILITY (3)

470. ELECTRONIC ANALOG COMPUTERS (3)

471. LOGICAL DESIGN OF DIGITAL COMPUTERS (3)

520. SEMINAR (1) Required of all graduate students in electrical engineering. Conferences, reading, and presentation of technical papers.

521. ADVANCED ELECTRICAL ENGINEERING PROBLEMS (2-12)

523. NONLINEAR ANALYSIS (3) Transient and steady state response of nonlinear physical systems, mathematical and graphical techniques, stability criteria. Prerequisite: E.E. 33.

525. SYMMETRICAL COMPONENTS (3) Polyphase circuits and machines under unbalanced conditions of operation including effects of rotating machines upon distribution and transmission system performance; characteristics of phase converters and single-phase operation of polyphase systems. Prerequisite: E.E. 425.

## ELECTRICAL ENGINEERING

528. SERVOMECHANISMS (3) Advanced treatment of transient and steady-state behavior of closed-cycle control systems with special attention to stability and design of stabilizing controllers. Prerequisite: E.E. 428.
532. ULTRA-HIGH-FREQUENCY ENGINEERING (3) Theory of wave guides and discontinuities, resonant cavities, traveling wave oscillators and devices; interaction of fields with matter. Prerequisite: E.E. 432 or 438.
535. ENGINEERING ANALYSIS (3) Engineering applications of complex variables, conformal mapping methods and potential plotting. Laplace transform methods and stability criteria. Prerequisite: E.E. 435.
538. ELECTROMAGNETIC ENGINEERING (3) Electrical and magnetic fields, using the Maxwell-Lorentz equations as applied to vector fields and special solutions for antennae, wave guides, and other engineering applications. Prerequisite: E.E. 438.
550. PASSIVE NETWORK SYNTHESIS (3) Network synthesis using (a) realizability conditions; (b) image parameters, realization methods for two-terminal pair networks; rational fraction approximation; time domain synthesis. Prerequisite: E.E. 450.
570. ADVANCED ELECTRONIC ANALOG COMPUTERS (3) Theory and design of linear and nonlinear function generators for electronic analog computers; methods of synthesizing physical systems. Prerequisite: E.E. 470.
571. DIGITAL COMPUTATION AND CONTROL (3) Methods of analysis of digital computers; analysis of sampled-data systems for real-time control purposes.
580. RADIO WAVES AND THE IONOSPHERE (3) The magneto-ionic theory of ionospheric wave propagation; ray-optical approximations; determination of ionization profiles; full wave solutions; nonlinear and coupling effects. Prerequisite: E.E. 43 or 438 or Phys. 557.
581. CONSTITUTION OF THE IONOSPHERE (3) Properties of the neutral and ionized atmosphere above 60 km height; photochemical processes causing them; solar ionospheric perturbations; large-scale movements.

## ELEMENTARY EDUCATION

A. MADISON BREWER, *Head of the Department*  
109 Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Bixby, Brewer, Murphy, and Russell; Associate Professors Alessandro, Bosch, Corle, Hunt, McAulay, and Veatch.

The graduate programs provide advanced professional preparation for kindergarten teachers, elementary school teachers, and curriculum specialists. For admission 18 credits in elementary education, including teaching experience, are required.

### ELEMENTARY EDUCATION (EL ED)

426. PROBLEMS OF ELEMENTARY SCHOOL ARITHMETIC (2-3)  
433. TEACHING SOCIAL STUDIES IN THE ELEMENTARY GRADES (2-3)

## ELEMENTARY EDUCATION

- 436. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE ELEMENTARY SCHOOL (3)
- 437. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE ELEMENTARY SCHOOL (3)
- 438. TEACHING SCIENCE IN THE ELEMENTARY SCHOOL (1-3)
- 443. THE ELEMENTARY SCHOOL READING PROGRAM (2-3)
- 444. READING DISABILITIES (2-3)
- 445. (Sec.Ed. 445) TECHNIQUES IN REMEDIAL READING (2-6)
- 449. TEACHING CHILDREN'S LITERATURE (2-3)
- 453. SPECIAL PROBLEMS IN THE TEACHING OF ELEMENTARY SCHOOL ENGLISH (2-3)
- 461. ELEMENTARY EDUCATION (2-3)
- 467. ADVANCED THEORY OF KINDERGARTEN (3)
- 479. MEASUREMENT OF ACHIEVEMENT IN THE ELEMENTARY SCHOOL (2-3)
- 485. WORKSHOP IN SELECTED STUDIES IN ELEMENTARY EDUCATION (1-6)
  
- 511. SUPERVISION OF STUDENT TEACHERS (3) A course in supervision for master teachers, department heads, and college teachers with supervisory responsibilities in teacher education. Prerequisite: teaching experience and 18 credits in education, including at least 5 in methods.
  
- 520. INTERNSHIP IN ELEMENTARY EDUCATION (3-6) Internship to take place in schools or educational situations where not regularly employed under supervision of graduate faculty.
  
- 546. (Sec.Ed. 546) SEMINAR ON READING INSTRUCTION (3-6) Research, procedures, and materials in reading readiness, word perception, basic reading skills, vocabulary development, reading in content subjects. Prerequisite: El.Ed. 443 or Sec.Ed. 443.
  
- 556. (Sec.Ed. 556) READING CLINIC PRACTICE: ANALYSIS OF READING DISABILITIES (3-6) Analysis of extreme reading disabilities and recommended remedial procedures; experience in preparation of case reports. Prerequisites: El.Ed. 444, Sec.Ed. 445.
  
- 557. READING CLINIC PRACTICE: REMEDIAL PROCEDURES (1-9) Practicum in special classes for reading disabilities; corrective and remedial procedures; specific procedures for correction of various types of reading disabilities. Prerequisite: El. Ed. 444 or 556.
  
- 559. READING CLINIC RESEARCH (1-15) Prerequisites: El.Ed. 444, Sec.Ed. 443; or El.Ed. 443.
  
- 562. PROBLEMS OF ELEMENTARY EDUCATION (2-3) Problems seminar for experienced educators. Prerequisite: 12 credits in education and psychology, including 6 in elementary education.
  
- 563. SEMINAR IN CONTEMPORARY ISSUES IN ELEMENTARY EDUCATION (1-3) Conferences and discussions designed to meet the needs of experienced teachers and principals in the field of elementary education. Prerequisite: 6 credits in elementary education and teaching experience.
  
- 564. ORGANIZATION OF THE ELEMENTARY SCHOOL CURRICULUM (2-3) Principles underlying curriculum construction. Primarily for elementary education majors. Prerequisite: El.Ed. 311 or teaching experience.
  
- 585. WORKSHOP IN CURRENT ELEMENTARY SCHOOL PROBLEMS (1-6) For experienced elementary school teachers, administrative, supervisory, and instructional problems involved in an emerging educational program. Prerequisite: 12 credits of graduate work in education.



594. SEMINAR IN EDUCATION (1-3) Conferences and discussions designed to meet the need for special study of particular fields in education. Prerequisite: 12 credits of graduate work in education.
598. PROBLEMS, PROJECTS, AND AREA STUDIES IN ELEMENTARY EDUCATION (1-6) Independent work in the study of topics in elementary education or the development of new curriculums, materials, or procedures for teaching. Prerequisites: 12 credits of graduate work in education and approval of the department head.

## ENGINEERING MECHANICS

JOSEPH MARIN, *Head of the Department*  
105 Hammond Building

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Professors Davids, Marin, Oppel, Vierck, and Wislicenus; Associate Professors Hardenbergh, Hu, and Jaunzemis; Assistant Professors Gaus, Sharma, and Wilkov.

Graduate study is available in dynamics and vibrations, theory of elasticity and strength of materials, experimental stress analysis, theory of plasticity, solid state mechanics, mechanical properties of materials, and fluid mechanics.

The entering student must hold a bachelor's degree in engineering or science and have satisfactorily completed undergraduate courses in statics, dynamics, and strength of materials.

### ENGINEERING MECHANICS (E MCH)

- |                                                   |                                 |
|---------------------------------------------------|---------------------------------|
| 400. ADVANCED STRENGTH OF MATERIALS (3)           | <i>Messrs. Gaus and Hull</i>    |
| 401. ELEMENTS OF VIBRATIONS (3)                   | <i>Mr. Vierck</i>               |
| 402. APPLIED AND EXPERIMENTAL STRESS ANALYSIS (3) | <i>Mr. Oppel</i>                |
| 403. MECHANICS OF THE SOLID STATE (4)             | <i>Mr. Hu</i>                   |
| 404. RESEARCH IN ENGINEERING MECHANICS (1-6)      |                                 |
| 407. NUMERICAL METHODS OF ANALYSIS (3)            | <i>Mr. Vierck</i>               |
| 408. ELASTICITY AND ENGINEERING APPLICATIONS (3)  | <i>Messrs. Hu and Jaunzemis</i> |
| 409. ADVANCED MECHANICS (3)                       |                                 |
| 410. MECHANICS OF SPACE FLIGHT (3)                | <i>Mr. Oppel</i>                |
| 412. EXPERIMENTAL METHODS IN VIBRATIONS (3)       |                                 |
| 413. PLASTIC ANALYSIS OF STRUCTURES (3)           | <i>Mr. Hu</i>                   |
| 414. ELEMENTS OF MATERIAL SCIENCE (3)             |                                 |
| 421. CONTINUUM MECHANICS (3)                      |                                 |
| 422. CONTINUUM MECHANICS (3)                      |                                 |
500. ADVANCED MECHANICS OF MATERIALS (3-6) Strain energy methods; special problems in bending and torsion; curved bars, beams on elastic foundations; thick-walled cylinders, shrink-fit assemblies, and rotating discs; thin-walled pressure vessels; bending of thin plates; buckling of bars and plates. Prerequisite: E.Mch. 13.  
*Mr. Marin*
504. APPLIED ELASTICITY (3) Analyses of stress and strain in two dimensions; problems in elasticity and elastic stability; emphasis on applications to machine and structural design. Prerequisite: E.Mch. 13.

## ENGINEERING MECHANICS

506. EXPERIMENTAL STRESS ANALYSIS (3) Experimental methods of stress determination including photoelasticity, stress coat and electric strain gauge techniques; stress analogies; strain rosettes for combined stress determinations. Prerequisite: E.Mch. 408 or 507. *Mr. Oppel*
507. THEORY OF ELASTICITY AND APPLICATIONS (3) Equations of equilibrium and compatibility; stresses and strains in beams, curved members, rotating discs, thick cylinders, torsion and structural members. Prerequisite: E.Mch. 13.
508. THEORY OF ELASTIC STABILITY AND APPLICATIONS (3) Buckling of slender and short members; buckling of I-beams; stability of thin-walled constructions; thin-walled cylinders subjected to internal pressures; applications to structural parts including aircraft members. Prerequisites: E.Mch. 12, 13.
509. THEORY OF PLATES AND SHELLS (3) Bending of circular and rectangular plates; buckling of plates; plates on elastic foundations; deformation of shells without bending; applications to engineering problems. Prerequisite: E.Mch. 13. *Mr. Oppel*
514. ENGINEERING MECHANICS SEMINAR (1 per term) Current literature and special problems in engineering mechanics.
516. MATHEMATICAL THEORY OF ELASTICITY (3) Stress and strain dyadics; conditions for single valued displacement; incompatibility dyadic; generalized Hooke's Law; uniqueness theorem; special topics in elasticity. Prerequisites: Math. 405, 417. *Mr. Jaunzemis*
520. ADVANCED DYNAMICS (3) Dynamics of a particle and of rigid bodies: Newtonian equations in moving co-ordinate systems; Lagrange's and Hamilton's equations of motion; special problems in vibrations and dynamics. Prerequisites: E.Mch. 12, Math. 44 or 431. *Mr. Davids*
522. THEORY OF VIBRATIONS (3) Mathematical theory of vibrating systems; damping phenomena; forced vibrations; analogy between mechanical and electrical vibrations; transverse and torsional oscillation of shafts; vibration of strings, beams, membranes, and plates. Prerequisites: E.Mch. 13, Math. 44 or 431. *Mr. Vierck*
523. RELAXATION METHODS (3) Relaxation methods compared to iteration and other numerical methods of analysis; application to elasticity, plasticity, stability, fluid flow, heat transfer, and related fields. Prerequisites: E.Mch. 13 or 111, Math. 44. *Mr. Vierck*
524. MATHEMATICAL METHODS IN ENGINEERING (3-6) Prerequisite: Math. 451 or E.E. 435 or M.E. 452. *Mr. Davids*
- Unit A (3) Matrix and tensor analysis, finite differences, relaxation, perturbation, and other approximate methods in solution of various engineering problems.
- Unit B (3) Energy methods, potentials, application to torsion problems, nonlinear problems, analogies and dimensional analysis, Bessel and other special functions, harmonic analysis.
526. NONLINEAR MECHANICS (3) Integral curves, singular points, self-sustained oscillations, stability problems, Hill's and Van der Pol's equation, mechanical and electrical applications. Prerequisite: E.Mch. 522. *Mr. Davids*
528. EXPERIMENTAL METHODS IN VIBRATIONS (3) Investigation of one or more degrees of freedom, free and forced mechanical vibrations, vibration properties of materials, vibration techniques in nondestructive testing. Prerequisite: E.Mch. 401 or 522.



## ENGINEERING MECHANICS

529. **ENGINEERING APPLICATIONS OF SONICS (3)** Sound and ultra sound in engineering and science; principles, radiation, transducers, devices for sonic processing and testing. Prerequisite: Phys. 443.
530. **SOLID STATE MECHANICS (3)** Relation between solid state physics and mechanics; mechanical properties for static, fatigue, creep, and impact conditions; high temperature properties; applications. Prerequisite: E.Mch. 14. *Mr. Marin*
531. **THEORY OF PLASTICITY AND APPLICATIONS (3)** Yield condition; plastic stress-strain relations; theory of slip-line fields; applications to bending, torsion, axially symmetric bodies, metal processing. Prerequisite: E.Mch. 504 or 507. *Messrs. Hu and Marin*
533. **DETERMINATION OF MECHANICAL PROPERTIES (3)** Experimental methods for determining hardness, elastic constants, creep behavior, fatigue strength, plastic flow, and dynamic properties of metals. Prerequisite: E.Mch. 14 or 530. *Mr. Hu*
534. **PHOTOELASTICITY (3)** Analysis of polariscopes; isoclinics, isochromatics, and stress trajectories; two- and three-dimensional photoelastic methods; determination of principal stresses; model preparation. Prerequisite: E.Mch. 408 or 507. *Mr. Oppel*
540. **MECHANICS OF CONTINUA (3)** Unified mathematical treatment of elements of fluid mechanics and of elasticity and plasticity of solids. Prerequisite: Math. 44 or 431. *Mr. Jaunzemis*
550. **STUDIES IN ENGINEERING MECHANICS (1-6)** Studies in any field of engineering mechanics.

## ENGLISH

PROFESSOR HENRY W. SAMS, *Head of the Department*  
246 Sparks Building

*Degrees Conferred:* Ph.D., D.Ed., M.A., M.Ed.

*Graduate Faculty:* Professors Bayard, Bowman, Condee, Cramer, Frank, Harris, Lewis, Major, Peck, Rubin, Sams, Sutherland, and Young; Associate Professors Bauer, Bressler, Davis, Morse, Reed, and Smith; Assistant Professors Austin, Hansen, Jewkes, Meserole, Oldsey, and Weintraub.

A student may specialize in English literature, American literature, philology, or rhetoric. It is preferred that an entering student present 24 credits in English, but 18 credits in English exclusive of survey and freshman courses will be accepted. If the student does not present 18 credits in English, he must make up the deficiency early in his graduate work.

### ENGLISH (ENGL)

408. **ADVANCED COLLEGE GRAMMAR (3)** *Miss McElwee*
412. **THE WRITING OF FICTION (3-6)** *Messrs. Rubinstein and Barth*
422. **MASTERS OF BRITISH LITERATURE (3-6)**
423. **HISTORY OF BRITISH LITERATURE (3)** *Mr. Major*
432. **MASTERS OF AMERICAN LITERATURE (3-6)** *Messrs. Bressler, Davis, and Staff*
433. **HISTORY OF AMERICAN LITERATURE (3)** *Messrs. Sutherland and Oldsey*



## ENGLISH

434. MOVEMENTS IN AMERICAN LITERATURE (3-6) *Messrs. Hansen, Meserole, and Staff*
437. AMERICAN POETRY (3) *Messrs. Rubin and Hansen*
438. AMERICAN DRAMA (3) *Mr. Bauer*
445. CHAUCER (3) *Mr. Frank*
446. MILTON (3) *Mr. Condee*
447. BRITISH POETRY FROM SKELTON TO DRYDEN (3) *Messrs. Reed and Smith*
448. ENGLISH DRAMA BEFORE SHAKESPEARE (3) *Mr. Harris*
449. SHAKESPEARE: THE CHRONICLE AND PROBLEM PLAYS (3) *Messrs. Reed and Smith*
451. PROSE AND POETRY OF 18TH CENTURY ENGLAND (3) *Messrs. Sams and Harris*
455. THE NOVEL IN ENGLAND TO CHARLES DICKENS (3) *Mr. Bowman*
458. THE DRAMA FROM DRYDEN TO SHERIDAN (3) *Mr. Harris*
461. BRITISH PROSE OF THE 19TH CENTURY (3) *Mr. Cramer and Miss Austin*
462. WORDSWORTH AND COLERIDGE (3) *Mr. Cramer and Miss Austin*
463. BYRON, SHELLEY, AND KEATS (3) *Mr. Peck*
465. VICTORIAN NOVEL (3) *Miss Austin*
466. THE AMERICAN NOVEL TO 1900 (3) *Messrs. Young and Oldsey*
467. VICTORIAN POETRY (3) *Mr. Cramer*
475. MODERN BRITISH FICTION (3) *Mr. Sutherland*
476. THE AMERICAN NOVEL SINCE 1900 (3) *Messrs. Young and Lewis*
477. BRITISH AND AMERICAN POETRY OF THE 20TH CENTURY (3) *Mr. Bauer*
478. BRITISH AND IRISH DRAMA SINCE 1890 (3) *Mr. Weintraub*
481. HISTORY OF ENGLISH LITERARY CRITICISM (3) *Messrs. Sams and Bressler*
488. MODERN CONTINENTAL DRAMA (3) *Mr. Bauer*
491. LITERATURE FOR TEACHERS IN SECONDARY SCHOOLS (3) *Mr. Bressler*
499. ENGLISH INSTITUTE (6-12)
501. MATERIALS AND METHODS OF RESEARCH (3) Materials and techniques of research in English and American literary history; form and content of theses. Required of all graduate students with an English major. *Messrs. Smith and Meserole*
521. OLD ENGLISH LANGUAGE (3) An introduction to the main features of the Old English language; readings in simple Old English prose and poetry. *Mr. Jewkes*
522. OLD ENGLISH LITERATURE (3) A reading of the more important poetic works in Old English; some reading in translation. *Mr. Jewkes*
540. STUDIES IN LITERATURE OF THE RENAISSANCE (3-6) *Messrs. Reed and Smith*
541. MEDIEVAL STUDIES (3) Seminar in special problems in medieval English literature. *Mr. Frank*
542. MIDDLE ENGLISH LITERATURE (3) Introduction to Middle English and its dialects; study of the literature of the period exclusive of Chaucer. *Mr. Frank*
543. STUDIES IN 17TH CENTURY LITERATURE (3-6) Topics will be drawn from any or all aspects of 17th century literature. *Mr. Harris*
544. RESTORATION LITERATURE (3) Selected studies of writers in England between 1650 and 1700. *Mr. Harris*
545. CHAUCER (3) A critical study of the principal works of Chaucer; emphasis on literary backgrounds and exegesis. *Mr. Frank*
548. SHAKESPEARE'S CONTEMPORARIES AND IMMEDIATE SUCCESSORS IN DRAMA (3) *Mr. Harris*

549. SHAKESPEARE (3) Special problems of sources, chronology, text, characterization, and motivation in the drama. *Mr. Bowman*
552. THE AGE OF SWIFT (3) Special studies varying from year to year. *Messrs. Harris and Sams*
553. THE AGE OF JOHNSON (3) The work of Johnson and his circle.
554. STUDIES IN AMERICAN LITERATURE TO 1812 (3) *Mr. Meserole*
561. STUDIES IN THE ROMANTIC MOVEMENT (3-6) *Messrs. Peck and Cramer*
562. STUDIES IN THE LITERATURE OF VICTORIAN ENGLAND (3-6) *Mr. Cramer and Miss Austin*
564. STUDIES IN AMERICAN LITERATURE, 1812 TO 1900 (3) The major figures treated will vary from year to year. *Messrs. Rubin, Davis, and Oldsey*
573. STUDIES IN CONTEMPORARY LITERATURE (3-6) *Messrs. Morse and Weintraub*
574. STUDIES IN AMERICAN LITERATURE SINCE 1900 (3) *Messrs. Young and Lewis*
581. CONTEMPORARY LITERARY CRITICISM (3) *Mr. Sams*
590. RESEARCH PROBLEMS IN ENGLISH (3-6) Methods of research in English, problems of bibliography, and method of evaluating sources and materials.
591. PROBLEMS IN AMERICAN LITERARY STUDY (3-6) *Messrs. Bressler, Davis, and Oldsey*
592. STUDIES IN AMERICAN LITERARY MYTH (3) An introduction to an interpretive, interdisciplinary study of some representative themes in American literature and culture. *Mr. Young*
593. ANGLO-AMERICAN FOLK SONG (3) Survey of relevant literary and ethnological scholarship and field work, European and American, from the early 16th century to the present. *Mr. Bayard*
595. STUDIES IN BRITISH FICTION (3) *Messrs. Sutherland and Bowman*
596. STUDIES IN AMERICAN FICTION (3) *Mr. Lewis*
597. STUDIES IN AMERICAN POETRY (3) *Messrs. Rubin, Davis, and Hansen*

## ENTOMOLOGY

BERTIL G. ANDERSON

*Head of the Department of Zoology and Entomology*

212 Frear Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors E. J. Anderson, Blackburn, Cheng, and Coon; Associate Professors Boyle and Rutschky; Assistant Professor Smyth.

A student majoring in entomology may specialize in apiculture, ecology, economic entomology, morphology, physiology, insect resistances of plants, taxonomy, or toxicology of insecticides.

## ENTOMOLOGY

For admission a student is required to have 24 credits in entomology or zoology and related biological sciences; and he should have had chemistry through organic chemistry. Courses in physics and mathematics are also advantageous. A limited deficiency may be made up, without degree credit, while pursuing graduate work.

### ENTOMOLOGY (ENT)

401. MEDICAL AND VETERINARY ENTOMOLOGY (3)  
403. (Zool. 403) SYSTEMATICS (3) *Mr. Boyle*  
405. INSECT MORPHOLOGY (3) *Mr. Rutschky*  
413. ENTOMOLOGY SEMINAR (1 per term)  
429. PRINCIPLES OF INSECT CONTROL (3) *Mr. Blackburn*  
431. ENTOMOLOGICAL PROBLEMS (1-6)  
445. THE IDENTIFICATION OF INSECTS (3)
505. ADVANCED MORPHOLOGY OF INSECTS (3) Advanced work in either external or internal morphology of insects. Prerequisites: Ent. (Zool.) 403, Ent. 405. *Mr. Rutschky*
506. IMMATURE INSECTS (3) The morphology and taxonomy of the immature stages of insects. Prerequisite: 9 credits in entomology. Spring term, even years. *Mr. Blackburn*
508. THE BIOLOGICAL CONTROL OF INSECTS (2) Artificial use of bacteria, fungous diseases, and animals in control of injurious insects; methods and equipment for rearing parasites and predators on a large scale. Prerequisites: Ent. 6, 8.
509. ENTOMOLOGICAL TECHNIQUE (2) For advanced students dealing with special methods of collecting, rearing living insects, preparing and preserving immature stages, keeping records, and preparing illustrations for manuscript. Prerequisite: Ent. 6. Fall term, odd years. *Mr. Coon*
514. ADVANCED SYSTEMATIC ENTOMOLOGY (1-10 per term) Taxonomy of various orders of insects selected to meet the needs of the individual student. Prerequisites: Ent. (Zool.) 403, Ent. 405. *Mr. Boyle*
520. SPECIAL TOPICS (1-6)
528. INSECT PHYSIOLOGY (4) Normal functions of the insect body. Fall term, even years. *Mr. Smyth*
531. INSECT TOXICOLOGY (2) General principles of toxicology and survey of the actions of substances toxic to insects. Fall term, odd years. *Mr. Smyth*
540. INSECT RESISTANCE IN PLANTS (2) Mechanism, expression, permanence, and measurement of resistance to insects with special reference to farm crops. Spring term, odd years. *Mr. Coon*

## EXTENSION EDUCATION

EMORY J. BROWN

*Chairman of the Committee on Extension Education*

205 Weaver Building

*Degrees Conferred: M.Agr., M.Ed.*

This program is designed primarily to meet the needs of professional teachers in various extension and adult education positions. The purpose is to train individuals



to develop attitudes, understandings, and competencies which enable them to become more effective professional workers. Options have been developed for the Colleges of Agriculture and Home Economics. Additional options will be offered as they are developed by other Colleges.

Entrance requirements for an M.Ed. in this major include a minimum of 18 credits in education and 12 in the social sciences and a strong background in agriculture or home economics. Entrance requirements for the M.Agr. degree include a strong background in agriculture or home economics and a minimum of 12 credits in the social sciences.

For either degree a minimum of 30 credits is required, in addition to a professional paper. These credits should be distributed as follows: 12 credits in extension core courses, 6 in communication and/or education, and 12 in two areas of agriculture and/or home economics.

## FAMILY ECONOMICS AND HOME MANAGEMENT

DELPHA E. WIESENDANGER

*Head of the Department of Home Management, Housing, and Home Art*  
271 Home Economics South

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Harms, Montgomery, Ruef, and Wiesendanger.

In the graduate program family management practices, their effects upon members of the family unit, and the interaction of such practices with the local and national economy are studied in relation to principles of economics, philosophy, psychology, sociology, and political science.

Those interested in emphasizing a study of home management, family economics, family housing, and home equipment may do so through this major. There are no specific course requirements for admission.

### CONSUMER SERVICE AND EQUIPMENT (CS EQ)

413. HOME EQUIPMENT (3)

### FAMILY ECONOMICS AND HOME MANAGEMENT (FE HM)

415. HOUSEHOLD BUYING PRACTICES (3)

419. MANAGING FAMILY FINANCIAL RESOURCES (3)

423. (F.N. 423) FAMILY FOOD PURCHASING (2)

424. ECONOMIC CONDITIONS IN RELATION TO THE FAMILY (3)

439. MANAGEMENT PRINCIPLES IN HOME OPERATION (2)

442. RESIDENT EXPERIENCE IN HOME MANAGEMENT (3) Room and board will be charged at regular rates.

*Miss Chennault*

445. HOME MANAGEMENT EXPERIENCE (3)

*Miss Chennault*

477. FAMILY MANAGEMENT (3)

500. NONTHESIS RESEARCH (1-6) Nonthesis research problems.

515. CONSUMER PROBLEMS (2-3) Methods of securing, evaluating, and presenting data concerning household commodities. For home economics teachers in high schools, colleges, and adult classes. Prerequisites: F.E.H.M. 442, F.N. 220.

524. ECONOMIC PROBLEMS OF THE HOUSEHOLD (3) Economic problems of the present-day family; special emphasis on factors in household production, use of money income, and standards of living. Prerequisites: Econ. 14, F.E.H.M. 439.

## FAMILY ECONOMICS AND HOME MANAGEMENT

528. HOME MANAGEMENT SUPERVISION (2-3) Evaluation of objectives and techniques in organization, supervision, and teaching of the home management house experience. Prerequisite: F.E.H.M. 439.
543. HOME MANAGEMENT IN RELATION TO FAMILY LIVING (3) Includes work with families in solution of their management problems. Prerequisites: F.E.H.M. 439, F.N. 220. *Miss Wiesendanger*
544. PROBLEMS IN FAMILY ECONOMICS AND HOME MANAGEMENT (1-6) Investigation of selected problems in family economics and home management. Prerequisite: 6 credits of family economics or home management courses in home economics.
550. SEMINAR IN FAMILY ECONOMICS AND HOME MANAGEMENT (1-6) Discussion and reports on developments in family economics and home management.

## FOOD SERVICE AND HOUSING ADMINISTRATION

S. EARL THOMPSON

*Head of the Department of Hotel and Institution Administration*  
4A Home Economics Building

*Degrees Conferred:* M.S., M.Ed.

*Graduate Faculty:* Professors Atkinson and Thompson.

Graduate work in this field trains for management positions in institutions which provide food service and housing to large groups, such as hospitals, residence halls, children's homes, and other public and private organizations. For admission, a student should have a baccalaureate degree in this or a related field.

### FOOD SERVICE AND HOUSING ADMINISTRATION (FS HA)

402. FOOD SERVICE AND HOUSING LAYOUT AND DESIGN (2)
410. ADVANCED QUANTITY FOOD PRODUCTION (3)
425. FOOD AND LABOR MANAGEMENT AND CONTROL (3)
461. INSTITUTION ADMINISTRATION (3)
470. PROBLEMS IN FOOD SERVICE AND HOUSING ADMINISTRATION (3)
502. PROBLEMS IN INSTITUTION ADMINISTRATION (3-6) Individual study of problems in institution administration. Prerequisites: F.S.H.A. 310, 330. *Miss Atkinson*

## FOODS AND NUTRITION

MIRIAM E. LOWENBERG, *Head of the Department*  
202A Home Economics Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., and M.Ed. in Foods and Nutrition; M.S. in Nutrition in Public Health (offered in co-operation with the University of Pittsburgh).

*Graduate Faculty:* Professors Dodds, Gordon, Lowenberg, and Pike; Associate Professors Fuqua and Olson.

## FOODS AND NUTRITION

Graduate programs in foods and nutrition prepare students for careers in high school teaching, college teaching, research, and adult program leadership. The program in nutrition in public health prepares the student for work in public health agencies.

For admission to a graduate program in foods and nutrition, a student must have completed at least 9 credits in organic and inorganic chemistry, 3 in biological chemistry, 3 in bacteriology, 3 in physiology, 4 in other physical and biological sciences, and 8 to 10 in foods and nutrition.

For admission to the program in nutrition in public health, the requirements are at least 9 credits in inorganic chemistry, 3 in biological chemistry, 3 in bacteriology, 12 in social sciences, 7 in foods, and 4 in nutrition.

### FOODS AND NUTRITION (F N)

400. SPECIAL PROBLEMS IN FOODS AND NUTRITION (1-3)  
420. EXPERIMENTAL COOKERY (1-6) *Miss Olson*  
421. ADVANCED FOODS (3) *Mrs. Jennings*  
422. SCIENTIFIC PRINCIPLES OF FOOD PREPARATION (3) *Miss Gordon*  
423. (F.E.H.M. 423) FAMILY FOOD PURCHASING (2)  
425. FOOD PRESERVATION (2)  
426. RECENT DEVELOPMENTS IN FOODS (3)  
452. ELEMENTS OF DIET IN DISEASE (3) *Miss Pike*  
455. TEACHING NUTRITION TO BOYS AND GIRLS (3)  
456. NUTRITION IN THE COMMUNITY (3) *Miss Lowenberg*  
457. PRINCIPLES OF NUTRITION (3) *Miss Fuqua*  
458. APPLIED NUTRITION (2) *Miss Fuqua*  
459. ADVANCED NUTRITION (3)  
490. FOODS AND NUTRITION SEMINAR (1)  
  
520. READINGS IN FOODS (2) Critical review and reports of literature on selected food topics. *Miss Gordon*  
521. SEMINAR IN FOODS (1-6) Discussion and reports on current research in the foods field. Prerequisite or concurrent: F.N. 520. *Miss Gordon*  
522. ADVANCED EXPERIMENTAL FOODS (3) Experimental methods used in measuring the quality of foods; specific problems in food preparation. *Miss Gordon*  
530. PROBLEMS IN FOODS AND NUTRITION (1-6)  
531. ADVANCES IN FOODS AND NUTRITION (3) Recent findings in the related areas of foods and nutrition.  
550. READINGS IN NUTRITION (3) Readings and reports of selected topics in nutrition. Prerequisite: F.N. 457.  
551. SEMINAR IN NUTRITION (1-6) Selected topics and recent advances in nutrition.  
552. NUTRITION IN DISEASE (3) Physiological and biochemical problems in metabolic diseases and the nutritional aspects of therapy. *Miss Pike*  
553. NUTRITION OF CHILDREN (3) Nutritional needs of the normal child during prenatal life, infancy, and childhood. Prerequisites: A.B.Ch. 35, F.N. 457.  
555. FIELD WORK IN NUTRITION (2-4) Field problems planned to meet the needs of individual students. Hours and problems to be arranged. *Miss Lowenberg*  
556. THE SURVEY METHOD IN FOODS AND NUTRITION (2) Study of survey technique as a tool in the assay of food adequacy and nutritional status. *Miss Dodds*  
557. INTERRELATIONSHIPS OF NUTRIENTS (2) Interrelationships of nutrients in the metabolic processes; their significance as applied to nutrition. *Miss Pike*



## FORESTRY

PETER W. FLETCHER  
*Director of the School of Forestry*  
 102 Forestry Building

*Degrees Conferred:* M.S., M.F.

*Graduate Faculty:* Professors Bartoo, Chisman, Fletcher, Goddard, Humphrey, McDermott, Norton, Sharp, and White; Associate Professor Byrnes; Assistant Professors Gerhold and Sopper.

A student may specialize in forest management, silviculture, wildlife management, wood utilization, wood technology, or forest products.

A B.S. degree in forestry normally provides the minimum preparation for specialization in any of the above areas except wood utilization. A B.S. degree in wood utilization, or a similar program emphasizing mathematics and basic engineering courses, provides the minimum preparation for specialization in wood utilization and is acceptable for advanced work in wood technology and forest products. Preparation for graduate work in wildlife management may be secured in any program which has emphasized land management and has included work in dendrology, silvics, forest measurement, and forest management.

Students with limited deficiencies may be admitted but must make up deficiencies without degree credit.

### FORESTRY (FOR)

- 421. REGIONAL SILVICULTURE (3)
- 427. FOREST RANGE MANAGEMENT (3)
- 445. IMPROVEMENTS (3)
- 450. DESIGN AND ANALYSIS OF EXPERIMENTS (3)
- 455. FOREST PHOTO INTERPRETATION (3)
- 466. FOREST MANAGEMENT AND MANAGEMENT PLANS (3)
- 469. PROBLEMS IN FORESTRY (1-9)
- 480. POLICY AND ADMINISTRATION (3)
- 481. FOREST WATERSHED MANAGEMENT (3)
- 491. LOGGING AND LUMBERING (3)
- 497. SMALL SAWMILLS (3)
  
- 504. RESEARCH METHODS IN FORESTRY (2-6 per term) Review of methods employed in conducting forestry research.
- 508. FOREST ECOLOGY (2-4) Organization, development, and classification of forest communities.
- 509. COVERT MANAGEMENT (2) Management of forest associations for maintenance and development of wildlife. Prerequisite: For. 508.
- 510. FORESTRY SEMINAR (1-2 per term) Current problems of forest research presented as weekly seminar reports. May be repeated with additional credit for each term's work.
- 550. FOREST MENSURATION (2-8 per term) Research in some chosen field. Prerequisite: For. 450.
- 560. FOREST MANAGEMENT (3-8) Special topics in forest management and research in some chosen field. Prerequisite: For. 466.

575. APPLICATIONS OF FOREST ECONOMICS AND FINANCE (3 per term) Survey of situations in forestry where business problems and particular circumstances of production, value, and costs are currently significant. Prerequisite: For. 70.
590. THE LUMBER INDUSTRY (2-4) Relation of the lumber industry to national economy and world trade; lumbermen's associations; lumber accounts.
591. PROBLEMS IN LOGGING AND LUMBERING (2-6) Research in some chosen phase of lumbering. Prerequisite or concurrent: For. 590.

## WOOD UTILIZATION (W U)

404. MECHANICAL PROPERTIES OF WOOD (3)
405. VENEER AND PLYWOOD (3)
424. (Bot. 424) COMMERCIAL TROPICAL WOODS (3)
431. PROBLEMS IN FOREST PRODUCTS (3-6)
435. SEASONING AND PRESERVATION (3)
437. ADVANCED WOOD TECHNOLOGY (3)
462. DEFECTS IN WOOD (3)
492. LUMBER DISTRIBUTION (3)
495. MILLING AND COSTS IN THE FOREST PRODUCTS INDUSTRIES (3)
502. WOOD FIBERS (3-5) Identification and physical and chemical characteristics of wood fibers used for pulp, either for paper or as a source of cellulose. Pulping quality, fiber measurements.
510. WOOD UTILIZATION SEMINAR (1-2 per term)
530. PROBLEMS IN WOOD UTILIZATION (3-6 per term) Prerequisite: W.U. 431.
531. STRUCTURAL USES OF WOOD AND WOOD PRODUCTS (3-6 per term) Wood as a construction material; testing techniques for structural timbers and wood assemblies; use of laminated wood, ring connectors, and other types of special construction. Prerequisite: W.U. 404.
532. LAMINATES (3-6 per term) Advanced and special studies in fabrication and use of plywood, laminated wood, paper-base laminates, and wood-to-metal bonding. Prerequisite: W.U. 405.
535. CONDITIONING TREATMENTS FOR WOOD (3-6 per term) Advanced study and problems in preservative, seasoning, and other special treatments for wood and wood products. Prerequisite: W.U. 435.

## FUEL TECHNOLOGY

HOWARD B. PALMER, *Head of the Department*  
316 Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Palmer and Walker; Associate Professors Austin, Essenhight, and Given; Assistant Professors Polansky and Vastola.

The graduate program includes the chemistry, physics, and combustion processes of solid, liquid, and gaseous fuels, with research opportunities in all of these areas.

For admission, a bachelor's degree with undergraduate training is necessary in one of the following: chemistry, chemical engineering, mechanical engineering, physics, or fuel technology.

## FUEL TECHNOLOGY

### FUEL TECHNOLOGY (F T)

- |                                                  |                        |
|--------------------------------------------------|------------------------|
| 400. FUEL TECHNOLOGY RESEARCH AND DESIGN (1-3)   |                        |
| 402. CHEMICALS FROM FUELS (2)                    | Mr. Given              |
| 405. COMBUSTION CALCULATIONS (3)                 | Mr. Austin             |
| 406. GASEOUS COMBUSTION (3)                      | Mr. Palmer             |
| 408. COMBUSTION AND GASIFICATION ENGINEERING (4) | Mr. Essenhigh          |
| 409. COKES, CARBONS, AND GRAPHITES (2)           | Mr. Walker             |
| 410. FUEL TECHNOLOGY LABORATORY (2)              | Mr. Polansky and Staff |
| 411. JET AND ROCKET FUELS (2)                    | Mr. Palmer             |
| 414. FUEL ENGINEERING ANALYSIS (2)               | Mr. Austin             |
| 415. NEW SOURCES OF ENERGY (2)                   | Mr. Vastola            |

503. COALIFICATION AND COAL CHEMISTRY (3) Chemical changes during the coalification process; chemical and physical constitution and classification of coals; relations between coal chemistry and constitution. Prerequisite: Chem. 31.

Mr. Given

506. KINETICS OF CARBON REACTIONS (3) Current approaches to heterogeneous reactions in combustion and gasification of coals and carbons. Prerequisites: Chem. 451, F.T. 409.

Mr. Walker

510. SPECIAL TOPICS IN FUEL TECHNOLOGY (1-6 per term)

511. FUEL TECHNOLOGY SEMINAR (1 per term) Selected topics from current fuel technology research examined and discussed.

512. HIGH TEMPERATURE KINETICS AND FLAME PROPAGATION (3) Laminar and turbulent premixed and diffusion flames; gaseous detonations; rate processes in high temperature gases. Prerequisite: F.T. 406.

Mr. Palmer

515. CATALYSIS OF FUEL REACTIONS (2) Principles of chemisorption and catalysis; mechanisms of specific catalytic reactions and practical aspects of catalytic processes in the fuels industries. Prerequisite: Chem. 452.

Mr. Walker

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in fuel technology studies are listed under Mineral Sciences in Part II of this bulletin.*

## GENERAL FAMILY STUDIES

DOROTHY HOUGHTON, *Professor of Home Economics*  
103C Home Economics Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

Because this program is planned for teachers in secondary schools or small colleges and others who wish to become proficient in several areas of home economics, the student must have a strong home economics background for admission.

The major for the M.S. or M.Ed. degree consists of a minimum of 6 credits in each of three areas of home economics. Three areas in this field are also the basis for the major at the doctoral level. However, the minimum credit requirements in each area are established after consultation with a committee which reviews all previous work.



## GENERAL FAMILY STUDIES

The student chooses a minor field of educational foundations or one of the applied fields, such as home economics education, secondary education, or higher education.

### GENERAL FAMILY STUDIES (G F S)

499. INTERCULTURAL STUDIES IN HOME ECONOMICS (2-6)

502, 502v. HOME ECONOMICS AND AMERICAN SOCIETY (3) Family life education in relation to a democratic culture; emphasis upon the interrelatedness of socio-economic problems and the American family.

503. GRADUATE SEMINAR IN HOME ECONOMICS (1) *Miss G. M. Henderson*

516, 516v. METHODS OF RESEARCH IN HOME ECONOMICS (3) Review of problems and techniques of research in home economics. Required of all graduate students in home economics. *Miss Ray and Mrs. Siegel*

530. SELECTED PROBLEMS IN GENERAL HOME ECONOMICS (1-6)

## GENETICS AND BREEDING

JAMES E. WRIGHT, *Chairman of the Committee on Genetics and Breeding*  
307 Buckhout Laboratory

*Degrees Conferred:* Ph.D., M.S.

Graduate programs are offered in the fields of theoretical and applied genetics. Courses in genetics and breeding are given by various departments. The basic and theoretical courses are listed under identical numbers in the Department of Botany and Plant Pathology and the Department of Zoology and Entomology. Courses dealing with genetic principles as applied to specific organisms are offered in the Departments of Agronomy, Animal Husbandry, Bacteriology, Horticulture, and Poultry Husbandry. The graduate committee for majors shall be appropriately represented by members of theoretical and applied phases who shall have the responsibility and jurisdiction for determining course work and research acceptable in satisfying degree requirements.

For entry as a major in this field no fewer than 15 credits in basic biology and 15 credits in the areas of chemistry, mathematics, and physics are required.

The following courses are available in genetics and breeding, and their descriptions may be found under the offerings of the several departments: Agro. 411, 509, 510, 582; A.H. 501, 505; Bact. 516; Bot. (Zool.) 405, 422, 505, 524, 528, 533; Hort. 444, 503, 520; P.H. 402, 505.

## GEOGRAPHY

E. WILLARD MILLER, *Head of the Department*  
202 Mineral Sciences Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Deasy, Miller, and Rodgers; Associate Professor Griess; Assistant Professors Lewis and Simkins.

## GEOGRAPHY

Students may concentrate on physical geography, human geography, political geography, economic geography, cartography, or some aspect of regional geography.

Because physical geography is a branch of the physical sciences and human, political, and economic geography are branches of the social sciences, a student may enter graduate work under either of two options. Option 1, for the student who wishes to specialize in physical geography, requires the completion of 18 undergraduate credits in geography and 20 credits in mathematics and biological and physical sciences, including at least 6 credits in geology. Option 2, for the student who wishes to specialize in human, political, or economic geography, requires 18 undergraduate credits in geography plus 20 credits in the social sciences, including at least 3 in economics.

### GEOGRAPHY (GEOG)

- |                                                 |                    |
|-------------------------------------------------|--------------------|
| 400. REGIONAL GEOGRAPHY OF NORTH AMERICA (3)    | <i>Mr. Deasy</i>   |
| 405. GEOGRAPHY OF POPULATION AND SETTLEMENT (3) | <i>Mr. Simkins</i> |
| 420. URBAN GEOGRAPHY (3)                        | <i>Mr. Rodgers</i> |
| 427. REGIONAL GEOGRAPHY OF THE SOVIET UNION (3) | <i>Mr. Rodgers</i> |
| 433. REGIONAL CLIMATOLOGY (3)                   | <i>Mr. Little</i>  |
| 442. GEOGRAPHY OF EUROPE (3)                    | <i>Mr. Miller</i>  |
| 443. GEOGRAPHY OF THE ORIENT (3)                | <i>Mr. Whitney</i> |
| 444. GEOGRAPHY OF AFRICA (3)                    | <i>Mr. Smith</i>   |
| 452. INTERPRETATION OF AERIAL PHOTOGRAPHS (3)   | <i>Mr. Deasy</i>   |
| 460. POLITICAL GEOGRAPHY (3)                    | <i>Mr. Lewis</i>   |
| 480. GEOGRAPHY OF WORLD MANUFACTURING (3)       | <i>Mr. Miller</i>  |
| 490. PHYSICAL GEOGRAPHY FOR TEACHERS (3)        | <i>Mr. Lewis</i>   |
503. ADVANCED REGIONAL GEOGRAPHY (3-12) Intensive study at an advanced level of selected regions or sections of the continents. Prerequisite: 12 credits in geography.
504. PHYSICAL GEOGRAPHY SEMINAR (3-12) The literature of some phase of physical geography with emphasis on procedures for organizing material for classroom reports and discussions.
505. ECONOMIC GEOGRAPHY SEMINAR (3-12) The literature of some phase of economic geography with emphasis on procedures for organizing material for classroom reports and discussions.
506. CULTURAL AND POLITICAL GEOGRAPHY SEMINAR (3-12) The literature of some phase of cultural and political geography with emphasis on procedures for organizing material for classroom reports and discussions.
507. DEVELOPMENT OF GEOGRAPHIC THOUGHT (1-6) Critical analysis of the growth of geographic thought from antiquity to the present; emphasis on structure of modern geography.
510. PHYSICAL GEOGRAPHY RESEARCH (3-10) Original study in physical geography: a field problem or detailed library investigation with analysis and presentation of data.
511. ECONOMIC GEOGRAPHY RESEARCH (3-10) Original study in economic geography: a field problem or detailed library investigation with analysis and presentation of data.
512. CULTURAL AND POLITICAL GEOGRAPHY RESEARCH (3-10) Original study in cultural and political geography: a field problem or detailed library investigation with analysis and presentation of data.

## GEOLOGY

LAUREN A. WRIGHT, *Head of the Department*  
110 Mineral Sciences Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Jahns, Krynine, Ridge, Spackman, Swartz, and Wright; Associate Professors Burnham, Lattman, Scholten, and Williams; Assistant Professors Barnes, Schmalz, and Taylor.

Graduate work in this field offers opportunity for specialization in stratigraphy, paleontology, paleobotany, palynology, regional and structural geology, geomorphology, ground water geology, marine geology and chemical oceanography, coal geology, and geology of metallic and nonmetallic deposits.

Prerequisites for admission include 25 credits in an approved combination of chemistry, physics, mathematics, and biological sciences, and at least 18 credits in geology and mineralogy.

## GEOLOGICAL SCIENCES (G SC)

- |                                         |                     |
|-----------------------------------------|---------------------|
| 400. GEOLOGY FOR TEACHERS (3)           |                     |
| 410. STRUCTURAL GEOLOGY (3)             |                     |
| 420. PALEOBOTANY (3)                    | <i>Mr. Spackman</i> |
| 421. INTRODUCTION TO COAL PETROLOGY (3) | <i>Mr. Williams</i> |
| 422. INTRODUCTORY PALYNOLOGY (3)        |                     |
| 430. PALEONTOLOGY (3)                   | <i>Mr. Swartz</i>   |
| 440. MARINE GEOLOGY (3)                 | <i>Mr. Schmalz</i>  |
| 451. ECONOMIC GEOLOGY (3)               | <i>Mr. Ridge</i>    |
| 461. GEOLOGY OF THE UNITED STATES (3)   |                     |
| 462. PRINCIPLES OF GEOMORPHOLOGY (3-6)  | <i>Mr. Lattman</i>  |
| 470. INTRODUCTION TO FIELD GEOLOGY (3)  |                     |
| 472. FIELD GEOLOGY (5)                  |                     |
| 481. GEOLOGY OF OIL AND GAS (3)         | <i>Mr. Scholten</i> |
| 490. PALEOZOIC STRATIGRAPHY (3)         | <i>Mr. Swartz</i>   |
| 491. STRATIGRAPHY FIELD TRIPS (1)       | <i>Mr. Swartz</i>   |
| 492. PENNSYLVANIAN STRATIGRAPHY (3)     |                     |

## GEOLOGY (GEOL)

- \*500. GEOLOGY SEMINAR (1-9) Presentation, at weekly departmental meetings, of topics selected from geological literature.
- †501. STRATIGRAPHY (3-12) Principles of stratigraphic classification, lithofacies and biofacies, faunal zonation, correlation, sedimentation, and paleogeography, illustrated by stratigraphy of classical geologic regions: (a) Pre-Cambrian; (b) Paleozoic; (c) Mesozoic; (d) Cenozoic. Prerequisite: G.Sc. 430. *Mr. Swartz*
- †503. PALEONTOLOGY (3-9) Morphology of animal groups significant for their fossils; nature of species and faunal zones. Seminars may be arranged for studies of special fossil groups, microfossils, paleoecology. *Mr. Swartz*

\*Credits to be arranged, 1 to 6 per term.

†Credits to be arranged, 3 to 6 per term.



## GEOLOGY

504. HISTORY AND FOUNDATIONS OF GEOLOGY (2-3) Development through the ages of scientific thought in the earth sciences. *Mr. Krynine*
507. SEMINAR IN GEOMORPHOLOGY (3-6) Classic and current literature in geomorphology. *Mr. Lattman*
511. ORE DEPOSITS: PRINCIPLES (3-6) Geological and geochemical processes controlling ore deposition; genetic classification of ore deposits. Prerequisite: G.Sc. 451. *Mr. Ridge*
512. ORE DEPOSITS: TYPES (1-6) Geologic history and field examination of selected ore bodies; forming media; causes, sequences, and loci of emplacement; wall rock alteration; secondary enrichment. Prerequisite: Geol. 511. *Mr. Ridge*
515. ORE MICROSCOPY (2-3) Theory and use of the ore microscope in identifying ore minerals in polished section, establishing paragenetic sequences, determining manner of deposition.
520. SEMINAR IN PALEOBOTANY (2-6) Current and classic literature concerning evolution, paleoecology, and geologic history of vascular plants. *Mr. Spackman*
524. COAL PETROLOGY (1-6) Microscopy, source materials, coalification, constitution, classification of peats, lignites, bituminous coal, anthracite. *Mr. Spackman*
526. PROBLEMS IN PALYNOLOGY (3-9) Systematics; paleoecological palynology; Paleozoic palynology; Mesozoic and Cenozoic palynology; Pleistocene vegetational history.
530. GEOLOGICAL PROBLEMS (3-6) Study, from the literature, of a selected geological problem. Prerequisite: 10 credits in geology and mineralogy.
540. CHEMICAL OCEANOGRAPHY (3) Chemical reactions in sea water and at the sea floor related to sedimentation and diagenesis. *Mr. Schmalz*
545. GLACIAL GEOLOGY (3) Glaciers: their characteristics, causes, deposits, land forms, effects in periglacial regions. *Mr. Lattman*
546. PRINCIPLES OF PHOTOGEOLOGY (3) Use of aerial photographs and mosaics in structural, geomorphic, and rock distribution studies and in compilation of maps. Prerequisites: G.Sc. 410, 462. *Mr. Lattman*
551. GEOTECTONICS (3-6) Tectonic principles and elements: nature and development of geosynclines, island arcs, mountain structures, stable masses, cratons, mobile belts. *Mr. Scholten*
555. ADVANCED STRUCTURE AND PETROFABRICS (1-3) Macroscopic and microscopic recognition, measurement, and interpretation of small-scale rock structures and mineral orientation patterns in deformed rocks.
571. HABITAT OF OIL (3) Geologic setting of petroleum as determined by basin tectonism, sedimentation, hydraulic and capillary forces, and reservoir textures. *Mr. Scholten*
590. GEOLOGY FIELD TRIP (1 per year) Field study of regional geologic features with trips in successive years to differing geologic provinces. Required each spring of all graduate students in geology.

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in geological studies are listed under Mineral Sciences in Part II of this bulletin.

# G E O P H Y S I C S   a n d   G E O C H E M I S T R Y

B. F. HOWELL, JR., *Head of the Department*  
220 Mineral Sciences Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Bell, Greig, Howell, Keith, Osborn, Roy, and Tuttle; Associate Professors Burnham and Herzog; Assistant Professors Barnes, Crowe, Dachille, and McKinstry; Mrs. Roy.

Graduate work is offered in the field of geophysics (geophysical prospecting, seismology, gravity, well logging, radioactive age determinations, tectonics, physical properties of rocks) and in the field of geochemistry (crystal chemistry, phase equilibria, element distribution and affiliations, isotope geochemistry, geochemical prospecting, cosmochemistry, high-temperature and high-pressure geochemistry).

Before starting graduate study an applicant is generally expected to have had (1) a standard introductory course in each of the following four subjects: chemistry, physics, geology, and mineralogy; (2) 12 semester hours of intermediate level work in any one or a combination of chemistry, physics, and geological science; and (3) mathematics through integral calculus (for geochemistry) or differential equations (for geophysics). Students who have taken somewhat less than the indicated minima in these subjects may be admitted, but must make up their deficiencies concurrently with their graduate studies.

## G E O L O G I C A L   S C I E N C E S   ( G   S C )

406.	PHYSICS OF THE EARTH (3)	Mr. Howell
407.	WELL LOGGING (3)	Mr. Crowe
408.	G E O P H Y S I C A L   S U R V E Y I N G   ( 3 )	Mr. Crowe
416.	ELECTRICAL SURVEYING (2)	Mr. Crowe
417.	SEISMIC SURVEYING (3)	Mr. Howell
418.	POTENTIAL THEORY APPLIED TO EARTH PROBLEMS (3)	Mr. Crowe
426.	G E O P H Y S I C S   F I E L D   W O R K   ( 1 - 4 )	Messrs. Crowe and Howell
456.	INTRODUCTORY GEOCHEMISTRY (3)	Mr. Keith
457.	G E O C H E M I C A L   P R O S P E C T I N G   ( 2 )	Mr. Barnes
458.	G E O C H E M I S T R Y   O F   A Q U E O U S   S Y S T E M S   ( 2 )	Mr. Barnes

## G E O P H Y S I C S   A N D   G E O C H E M I S T R Y   ( G   G )

500.	G E O P H Y S I C A L   S E M I N A R   ( 1   p e r   t e r m )	Discussion of geophysical reports and papers; scientific outlook.
501.	RESEARCH (1-10 per term)	Original research in geophysics or geochemistry.
502.	SEISMIC INSTRUMENTS (3)	Characteristics and design of seismometers and seismic recorders. Mr. Howell
503.	SPECIAL STUDIES IN GEOPHYSICS (1-9)	Special studies of the theories of geophysical methods.
507.	SEISMOLOGY (3)	Nature and transmission of seismic waves; cause and occurrence of earthquakes; applications in seismic prospecting. Mr. Howell
508.	TECTONICS (3)	Seminar in the cause and nature of the principal deformations of the earth. Mr. Howell

## GEOPHYSICS AND GEOCHEMISTRY

509. GEOCHEMISTRY SEMINAR (1 per term)
510. PROBLEMS IN GEOCHEMISTRY (1-9) Laboratory and library study of special problems.
512. INTRODUCTION TO HIGH-TEMPERATURE GEOCHEMISTRY (3) Ion configuration and radii; simple crystal structures; measurement and control of temperature and pressure; methods and principles of phase equilibrium determination.  
*Messrs. Roy and Osborn*
513. PHASE EQUILIBRIA IN MINERAL SYSTEMS I (2-3) Interpretation of phase-equilibrium diagrams with emphasis upon binary, ternary, and quaternary oxide systems at atmospheric pressure.  
*Mr. Osborn*
514. ELEMENT DISTRIBUTION IN THE EARTH (3) Principles and data from studies of phase equilibria, petrology, and crystal structure as related to distribution of elements in minerals, rocks, and the earth.  
*Mr. Burnham*
515. ELECTRIC WELL-LOGGING (2-3) Quantitative and qualitative methods of interpreting electrical resistivity, induction, and self-potential logs; comparison of electrical logging methods.
516. INTRODUCTION TO NUCLEAR PROCESSES IN GEOLOGIC SETTINGS (2) Natural radioactivity and its measurement, interpretation, and use in research and exploration.  
*Messrs. Herzog and Wright*
517. AGE DETERMINATIONS (1-2) Geochemistry of radioactive elements and their daughters; age determination techniques and observations.  
*Mr. Herzog*
518. ISOTOPE-RATIO VARIATIONS IN NATURE (2) Theoretical basis and observations of isotope fractionation in nature: paleotemperature scale; temperatures of formation of ore deposits and other rocks.
519. COSMOCHEMISTRY AND NUCLEOGENESIS (2) Distribution and composition of matter; origin of solar system and earth, of constituent nuclides, of life.  
*Mr. Herzog*
520. PHASE EQUILIBRIA IN MINERAL SYSTEMS II (2-3) Continuation of G.G. 513. Pressure as a variable; thermodynamic calculations and experimental methods pertaining to phase equilibrium diagrams. Prerequisite: G.G. 513.  
*Messrs. Tuttle and Roy*

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in geophysical and geochemical studies are listed under Mineral Sciences in Part II of this bulletin.*

## GERMAN

PHILIP A. SHELLEY, *Head of the Department*  
229 Sparks Building

*Degrees Conferred:* Ph.D., M.A., M.Ed.

*Graduate Faculty:* Professors Adolf, Buffington, and Shelley; Associate Professors de Levie and Striedieck.

There is opportunity for major emphasis upon either literature or philology. Minimum qualifications for admission include 18 undergraduate credits in German; provision is made, however, for admission with limited deficiencies.



GERMAN (GER)

401. ADVANCED STYLISTICS (3)
430. HISTORY OF THE GERMAN LANGUAGE (3) *Mr. Buffington*
443. (C.Lit. 443) LITERARY RELATIONS OF GERMANY WITH ENGLAND AND AMERICA (3-9) *Mr. Shelley*
454. LITERATURE FROM THE AGE OF CHIVALRY TO THE THIRTY YEARS' WAR (3) *Miss Adolf*
464. LITERATURE FROM THE BEGINNING OF THE ENLIGHTENMENT THROUGH STORM AND STRESS (3) *Messrs. Buffington and de Levie*
469. GOETHE'S LIFE AND WORKS (3) *Messrs. Buffington and de Levie*
474. CLASSICISM AND ROMANTICISM (3) *Miss Adolf*
484. LITERATURE FROM REALISM TO EXPRESSIONISM (3)
- \*1G. ELEMENTARY GERMAN FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees. *Messrs. Striedieck and de Levie*
- \*2G. ELEMENTARY GERMAN FOR GRADUATE STUDENTS (3) Continuation of Ger. 1G with opportunity for reading in special fields. *Messrs. Striedieck and de Levie*
500. BIBLIOGRAPHY AND RESEARCH TECHNIQUES (3) Introduction to tools and methods of research, designed for students preparing for independent investigation of problems in German literature and language. *Mr. Shelley*
531. MIDDLE HIGH GERMAN (3) Descriptive and historical grammar; reading and interpretation of texts. *Miss Adolf*
532. OLD HIGH GERMAN (3) Essentials of the grammar, with special treatment of the High German sound shift and of ablaut and umlaut; reading of works written before 1100 A.D. *Mr. Buffington*
533. GOTHIC (3) Essentials of the grammar; reading of Ulfilas' Bible translation. Suitable also for advanced students in English. *Miss Adolf*
541. SEMINAR IN THE LITERATURE OF THE REFORMATION AND BAROQUE (3) *Miss Adolf*
551. SEMINAR IN THE LITERATURE OF THE ENLIGHTENMENT AND THE AGE OF GOETHE AND SCHILLER (3-6) *Messrs. Buffington and de Levie*
561. SEMINAR IN POST-IDEALISTIC LITERATURE (3)
571. SEMINAR IN MODERN GERMAN LITERATURE (3)
581. SEMINAR IN LITERARY GENRES (3-12) Special studies in the German lyric, drama, short story, and novel.
591. SEMINAR IN GERMAN LITERARY CRITICISM (3)

## HIGHER EDUCATION

HUGH S. BROWN, *in Charge of Graduate Programs in Higher Education*  
212 Willard Building

*Degree Conferred:* D.Ed.

*Graduate Faculty:* Professors Brown, Patrick, and Wellington.

\*No graduate credit is given for this course.

## HIGHER EDUCATION

Graduate students with any undergraduate major may enter the program without other prerequisites. The following courses in higher education are listed under the offerings of the Department of Educational Services: Ed.Ser. 545 to 552 inclusive and 555 (See page 93). To complete a program to meet the student's needs, additional courses will be selected from other departments of the University.

Candidates for advanced degrees in other fields may elect higher education as a minor, subject to the restrictions concerning minors.

## HISTORY

ROBERT K. MURRAY, *Head of the Department*  
116 Sparks Building

*Degrees Conferred:* Ph.D., D.Ed., M.A., M.Ed.

*Graduate Faculty:* Professors Brown, Dahmus, Forster, Gray, Klein, Murray, Pundt, and Rayback; Associate Professors DeNovo, Green, Hassler, McNall, and Thaden; Assistant Professors Hoogenboom and Pixton.

Graduate work is offered in the following fields of history: ancient, medieval, early modern European, modern European, colonial American, 19th century American, modern American, British, Russian, Latin American, Far Eastern, political (European or American), economic (European or American); diplomatic (European or American), social and cultural (European or American).

For a master's degree the candidate must pass examinations in two of the first seven of the above fields. A candidate for a master's degree must also take work in a cognate field. For the doctorate, a candidate must pass examinations in four of the above fields, one of which must be his thesis field. He also must pass an examination either in another of the above history fields and a single cognate field, or in a study area made up of a number of academic disciplines related to his thesis field.

The entering student should present evidence of undergraduate course work covering the history of Europe from ancient times to the present and the history of America from its discovery to the present.

### HISTORY (HIST)

- |                                                                         |                               |
|-------------------------------------------------------------------------|-------------------------------|
| 401. ANCIENT CIVILIZATION (3)                                           |                               |
| 403. THE MIDDLE AGES FROM CONSTANTINE TO THE CRUSADES (3)               | Mr. Dahmus                    |
| 404. THE MIDDLE AGES FROM THE CRUSADES TO THE RENAISSANCE (3)           | Mr. Dahmus                    |
| 408. INTELLECTUAL HISTORY OF THE MIDDLE AGES (2-3)                      | Mr. Dahmus                    |
| 410. RENAISSANCE AND REFORMATION (3)                                    | Mr. Green                     |
| 413. THE AGE OF ABSOLUTISM (3)                                          | Mr. Green                     |
| 417. NINETEENTH CENTURY EUROPE (3)                                      | Mr. Forster                   |
| 419. RECENT EUROPEAN HISTORY (3)                                        | Mr. Forster                   |
| 422. HISTORY OF THE AMERICAN FRONTIER (3)                               | Mr. McNall                    |
| 425. HISTORICAL BACKGROUND OF AMERICAN POLITICAL PARTIES, 1607-1900 (3) | Mr. Hoogenboom                |
| 427. THE DIPLOMATIC HISTORY OF THE UNITED STATES (3)                    | Mr. DeNovo                    |
| 428. AMERICAN MILITARY HISTORY (3)                                      | Mr. Hassler                   |
| 431. COLONIAL AND REVOLUTIONARY AMERICA (3)                             |                               |
| 432. THE FORMATIVE PERIOD OF AMERICAN HISTORY (3)                       | Mr. Brown                     |
| 433. THE MIDDLE PERIOD OF AMERICAN HISTORY (3)                          | Mr. Klein                     |
| 434. THE UNITED STATES IN CIVIL WAR AND RECONSTRUCTION (3)              | Mr. Hassler                   |
| 435. THE EMERGENCE OF MODERN AMERICA (3)                                | Messrs. Murray and Hoogenboom |
| 436. RECENT AMERICAN HISTORY (3)                                        | Mr. Murray                    |

## HISTORY

- |                                                                      |                         |
|----------------------------------------------------------------------|-------------------------|
| 440. HISTORY OF ENGLAND AND GREAT BRITAIN SINCE 1485 (3)             | Mr. Linker              |
| 442. HISTORY OF RUSSIA TO 1861 (3)                                   | Mr. Thaden              |
| 443. HISTORY OF MODERN RUSSIA (3)                                    | Mr. Thaden              |
| 444. EASTERN EUROPE IN MODERN TIMES (3)                              | Mr. Thaden              |
| 447. SOCIAL AND ECONOMIC HISTORY OF EUROPE SINCE 1750 (3)            | Mr. Pundt               |
| 448. INTELLECTUAL AND CULTURAL HISTORY OF MODERN EUROPE (3)          |                         |
| 452. SOCIAL AND CULTURAL HISTORY OF THE UNITED STATES SINCE 1783 (3) | Mr. Brown               |
| 454. ECONOMIC DEVELOPMENT OF THE UNITED STATES (3)                   | Mr. McNall              |
| 456. HISTORY OF AMERICAN LABOR (3)                                   | Mr. Rayback             |
| 460. LATIN AMERICA AND THE UNITED STATES (3)                         | Mr. Gray                |
| 461. SOCIAL AND CULTURAL HISTORY OF LATIN AMERICA (3)                | Mr. Gray                |
| 471. HISTORY OF MODERN CHINA (3)                                     | Mr. Johnson             |
| 481. THE MIDDLE EAST IN MODERN TIMES (3)                             | Mr. DeNovo              |
| 499. FOREIGN STUDY IN HISTORY (2-6)                                  |                         |
|                                                                      |                         |
| 501. HISTORICAL METHOD (3)                                           | Mr. Klein               |
| 502. HISTORIOGRAPHY (3)                                              | Mr. Pundt               |
| 504. MEDIEVAL CIVILIZATION (3-9)                                     | Mr. Dahmus              |
| 505. THE AGE OF THE REFORMATION (3-6)                                | Mr. Green               |
| 508. STUDIES IN EUROPEAN HISTORY, 1600-1789 (3-6)                    | Mr. Pundt               |
| 509. EUROPE SINCE 1789 (3-6)                                         | Mr. Forster             |
| 512. STUDIES IN PENNSYLVANIA HISTORY (3-6)                           | Mr. Klein               |
| 520. COLONIAL AND REVOLUTIONARY AMERICA (3-6)                        |                         |
| 533. THE UNITED STATES, 1783-1860 (3-6)                              | Mr. Klein               |
| 534. THE UNITED STATES, 1860-1900 (3-6)                              | Mr. Brown               |
| 536. THE UNITED STATES IN THE 20TH CENTURY (3-6)                     | Mr. Murray              |
| 538. DIPLOMATIC HISTORY OF THE UNITED STATES (3)                     | Messrs. Gray and DeNovo |
| 539. ECONOMIC HISTORY OF THE UNITED STATES (3)                       | Mr. McNall              |
| 540. STUDIES IN BRITISH HISTORY (3-6)                                |                         |
| 545. STUDIES IN RUSSIAN AND SLAVIC HISTORY (3-6)                     | Mr. Thaden              |
| 550. PROBLEMS IN HISTORY (3-6)                                       |                         |
| 562. SEMINAR IN LATIN-AMERICAN HISTORY (3-6)                         | Mr. Gray                |
| 563. STUDIES IN THE HISTORY OF THE CARIBBEAN AREA (3)                | Prerequisites: Hist.    |
| 22, 23.                                                              | Mr. Gray                |
| 599. READINGS IN HISTORY (3)                                         |                         |

## HOME ART

JAMES E. MONTGOMERY, *Professor of Housing and Home Art*  
250 Home Economics South

No advanced degree is offered in this field, but a candidate with a major in another field may choose a minor in home art upon approval by his major department.



## HOME ART

### FAMILY HOUSING AND HOME ART (FH HAR)

400. SPECIAL PROBLEMS IN HOME FURNISHINGS (3)  
\*433. ADVANCED HOME CRAFTS (2-12)  
440. HOME FURNISHING PROBLEMS (3)  
447. HOME FURNISHINGS FOR THE FAMILY (3)  
470. HOUSING THE FAMILY (2-3)
515. BACKGROUNDS OF THE HOME ARTS (3) Evaluation of useful objects in respect to their form, function, and time; selections for exhibition. Prerequisites: F.H.H.Ar. 216 or Art 15 or A.Ed. 106, and A.A.H. 1 or F.H.H.Ar. 240.
530. PROBLEMS IN HOME ART (1-6) Individual investigation, analysis, and presentation. Prerequisite: 6 credits in family housing and home art, art education, or art.
541. ART IN THE ENVIRONMENT (3) Approach based upon human needs with consideration of materials in the light of their use in home living. Prerequisite: Art 14 or A.Ed. 105 or F.H.H.Ar. 440.

## HOME ECONOMICS EDUCATION

MARJORIE EAST, *Head of the Department*  
116B Home Economics Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors East and Hatcher; Associate Professor Ray.

Research and graduate courses may be chosen to give emphasis to special areas of interest in home economics education, such as curriculum development; evaluation; teaching at the elementary, secondary, adult, or higher education levels; supervision; administration in colleges; or research.

For admission the student must present approximately 50 credits of undergraduate work from the following areas: home economics education, education and/or psychology, aspects of home economics; the physical and biological sciences; and the social sciences.

### HOME ECONOMICS EDUCATION (HE ED)

- 406, 406v. TEACHING AIDS IN FAMILY LIFE EDUCATION (1-4)  
427, 427v. FAMILY LIFE EDUCATION (3)  
443, 443v. ADULT HOMEMAKING EDUCATION (3)  
463, 463v. SENIOR SEMINAR (2)  
466, 466v. STUDENT TEACHING (9)  
478, 478v. APPRAISING STUDENT PROGRESS IN EDUCATION FOR FAMILY LIVING (3)  
479, 479v. READINGS IN HOME ECONOMICS EDUCATION (1-4)  
480, 480v. PRACTICUM IN TEACHING HOME ECONOMICS IN THE SECONDARY SCHOOL (3-6)
- 502, 502v. HOME ECONOMICS INSTRUCTION AT THE COLLEGE LEVEL (3) Teaching techniques suitable for college instruction in home economics; for prospective home economics college teachers. *Mrs. East*
- 503, 503v. PROBLEMS IN HOME ECONOMICS TEACHER EDUCATION (3) Organization of college programs of teacher education; use of resources; records; field

\*Not more than 2 credits in each field.

## HOME ECONOMICS EDUCATION

services; recruitment and selection of personnel. Prerequisite: two years' experience in teaching home economics. *Miss Hatcher*

504, 504v. CURRENT DEVELOPMENTS IN EDUCATION IN RELATION TO HOME ECONOMICS (3) Opportunity for home economists to study newer developments in education. Prerequisite: one year's teaching experience in home economics. *Mrs. East*

509, 509v. CURRICULUM WORKSHOP IN FAMILY LIFE EDUCATION (3) Laboratory course in problems of curriculum building; individual problems in this field; frequent individual and group conferences. Prerequisite: one year's experience in teaching home economics. *Mrs. East or Miss Hatcher*

510, 510v. THE SUPERVISION OF HOME ECONOMICS TEACHING (2-6) For teachers of home economics desiring to qualify as city, county, or student teacher supervisors. Prerequisite: graduation from a four-year teacher education curriculum and two years' teaching experience in home economics. *Mrs. East*

518, 518v. EVALUATION IN FAMILY LIFE EDUCATION (3) Methods of evaluating progress toward goals in home economics education and use of findings in program planning and revision. *Miss Hatcher*

521, 521v. HOME ECONOMICS EDUCATION SEMINAR (2-3) Selected topics and recent developments in education for family living. Conferences and guidance relative to individual research problems.

526, 526v. THE COMMUNITY PROGRAM IN FAMILY LIFE EDUCATION (2-3) Ways of discovering community needs and resources; methods of developing the community program in family living; leadership education for the lay member of the community.

530, 530v. PROBLEMS IN HOME ECONOMICS EDUCATION (1-6 per term) Individual investigation of problems related to the teaching, supervision, or administration of home economics education.

## HORTICULTURE

RUSSELL E. LARSON, *Head of the Department*  
102 Tyson Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Fleming, Hitz, Larson, Mastalerz, Meahl, and Odland; Associate Professors McArdle, Ritter, Smith, Tukey, and Walker; Assistant Professors Bergman, Creech, and Pfahl.

Students may specialize in propagation, production, processing, breeding, nutrition, and other physiological studies of horticultural crop species, and in landscape design.

Prerequisites for major work in horticulture vary according to area of specialization; but basic courses in chemistry, mathematics, and the biological sciences are required. In addition, for students who wish to specialize in landscape architecture, basic courses in art and architecture and at least 30 credits in landscape architecture are required. Students who lack prerequisite courses may be admitted but are required to fulfill deficiencies without degree credit.

## HORTICULTURE

### HORTICULTURE (HORT)

412. STORAGE OF HORTICULTURAL CROPS (3) *Mr. Ritter*  
424. ADVANCED OLERICULTURE (3-6) *Mr. Odland*  
425. ADVANCED FRUIT AND VEGETABLE PROCESSING I (3) *Mr. McArdle*  
426. ADVANCED FRUIT AND VEGETABLE PROCESSING II (3) *Mr. McArdle*  
427. ADVANCED FLORICULTURE (3) *Mr. White*  
428. ADVANCED FLORICULTURE (3) *Mr. Mastalerz*  
444. ADVANCED PLANT BREEDING (3-6) *Mr. Walker*  
447. PROBLEMS IN HORTICULTURE (1-9)  
453. NURSERY PRINCIPLES AND PRACTICE (3) *Mr. Meahl*  
456. PROBLEMS IN NURSERY PRACTICE (3) *Mr. Meahl*
500. ECOLOGY OF FRUIT PLANTS (3) Factors limiting the distribution and intensity of culture of fruit species and varieties and effect of environmental factors on cultural practices. Spring term, even years. *Mr. Tukey*
501. EXPERIMENTAL PROBLEMS IN POMOLOGY (2-12) Investigation of problems involving review of literature, field and laboratory research.
503. EXPERIMENTAL PLANT BREEDING (2-12) Problems based mainly on research work of the department, with review of experimental methods and literature. Prerequisite: Hort. 444. *Mr. Larson*
504. EXPERIMENTAL PROBLEMS IN OLERICULTURE (2-9) Investigation of problems involving review of literature, field and laboratory research. Prerequisite: Hort. 424. *Mr. Odland*
505. PROBLEMS IN VEGETABLE PRODUCTION (2-6) Methods used in the more valuable contributions to vegetable production. Prerequisite: Hort. 424. *Mr. Odland*
506. NUTRITION OF HORTICULTURAL CROPS (2-4) Principles, applications, and interpretations of diagnostic methods for determining fertilizer requirements of horticultural crops. *Mr. Smith*
512. PRINCIPLES OF FRUIT AND VEGETABLE STORAGE (2-4) Principles involved in the maturation, storage, and senescence of fruits and vegetables, and their application. Winter term, odd years. *Mr. Ritter*
513. EXPERIMENTAL PROBLEMS IN ORNAMENTAL HORTICULTURE (2-12) Review of research in ornamental horticulture, with original investigations. *Mr. Meahl*
514. PROPAGATION OF ORNAMENTAL AND FRUIT PLANTS (3) Factors affecting the asexual and sexual propagation of fruit and ornamental plants. *Mr. Meahl*
517. HORTICULTURE SEMINAR (1 per term) Review of current research publications in horticulture. Each student presents one or more reviews of assigned topics.
519. SEMINAR ON THE GENETICS OF HORTICULTURAL CROPS (1 per term) Review of current research publications on the genetics of horticultural crops. Each student presents one or more reviews of literature on assigned topics.
520. SEMINAR ON THE BREEDING OF HORTICULTURAL CROPS (1 per term) Each student presents one or more reviews of literature on assigned topics.
523. PROPAGATION AND IMPROVEMENT OF VEGETABLE AND FLOWER CROPS (3) Methods and special techniques in breeding of flowers and vegetables; maintenance of seed stocks and seed production. Prerequisite: Hort. 444. Fall term, even years. *Mr. Odland*



## HORTICULTURE

524. EXPERIMENTAL PROCEDURES IN HORTICULTURAL RESEARCH (3) *Mr. Larson*
525. HORTICULTURAL RESEARCH TECHNIQUES (3) Practice in and comparison of methods and apparatus used in horticultural research. Winter term, even years. *Mr. Hitz*
526. EXPERIMENTAL PROBLEMS IN FLORICULTURE (2-12) Greenhouse research and review of literature. Prerequisite or concurrent: Hort. 427, 428. *Mr. Mastalerz*
527. EXPERIMENTAL PROBLEMS IN NUTRITION OF HORTICULTURAL CROPS (2-12) Review of current research; problems for independent investigation. *Mr. Smith*
528. PROBLEMS IN FRUIT AND VEGETABLE PROCESSING (2-12) *Mr. McArdle*

## LANDSCAPE ARCHITECTURE (L ARCH)

- 425-426. LANDSCAPE CONSTRUCTION PROBLEMS (3 each) *Mr. Wilson*
427. LANDSCAPE CONSTRUCTION PROBLEMS (2) *Mr. Wilson*
434. (Rc.Ed. 434) RECREATION AREAS AND FACILITIES (3) *Mr. Wilson*
- 454-455-456. LANDSCAPE DESIGN (3 each) *Mr. Miller*
- 460-461-462. ADVANCED LANDSCAPE DESIGN (4 each) *Mr. Polakowski*
471. PARK DESIGN AND ADMINISTRATION (2-4) *Mr. Wilson*
472. SITE PLANNING OF INSTITUTIONAL AND PUBLIC PROJECTS (2) *Mr. Miller*
473. SITE PLANNING OF INSTITUTIONAL AND PUBLIC PROJECTS (2) *Mr. Miller*
518. ADVANCED PROBLEMS IN LANDSCAPE DESIGN (2-12) Selected problems for original investigation in the design, construction, and maintenance of landscape architectural projects. Prerequisite: L.Arch. 456.
521. TECHNICAL LANDSCAPE ARCHITECTURAL PRACTICES (2-12) Specific technical and professional problems in landscape architectural planning and practice. Prerequisites: L.Arch. 462, 471.

## INDUSTRIAL ARTS EDUCATION and VOCATIONAL INDUSTRIAL EDUCATION

S. LEWIS LAND, *Head of the Department of Industrial Education*  
301 Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Land and Williams; Associate Professors Pendered, Shemick, and Schaefer.

Emphasis may be placed on preparation for teaching, supervision, administration, or teacher education. Graduation from an approved curriculum in industrial arts or in vocational industrial education is required for admission to the respective fields.

## INDUSTRIAL ARTS EDUCATION

### INDUSTRIAL ARTS (I ART)

400. SHOP MANAGEMENT AND LAYOUT (3)
407. CURRICULUM MATERIALS AND METHODS IN INDUSTRIAL ARTS (4)
470. PROBLEMS IN SENIOR HIGH SCHOOL INDUSTRIAL ARTS (3)
574. HISTORY AND PHILOSOPHY OF INDUSTRIAL ARTS (3) Historical developments and concurrent educational philosophies of industrial arts in American education. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.
575. PROBLEMS IN INDUSTRIAL ARTS EDUCATION (3) Subject matter, projects, methods of manual and informational teaching, aids and devices, selection of text and reference materials, personnel organization, shop management, problem pupils. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.
576. SUPERVISION AND ADMINISTRATION OF INDUSTRIAL ARTS EDUCATION (3) How to organize, supervise, and administer functioning programs of industrial arts; duties of a supervisor and director of industrial arts. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.
577. TESTING IN INDUSTRIAL ARTS (3) Construction of informal manipulative and written tests; use of standardized mechanical aptitude and achievement tests; construction and use of rating scales; scoring and grading; interpretation of test results. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.
578. RESEARCH IN INDUSTRIAL ARTS (3) Research techniques in industrial arts education. Prerequisite: 6 credits in professional courses in industrial arts.
580. SEMINAR IN INDUSTRIAL ARTS (2-9) Directed intensive study, investigation, or research in selected phases of the program; reports and constructive criticism. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.

### INDUSTRIAL EDUCATION (I ED)

- 402v. SUPERVISION OF VOCATIONAL EDUCATION (3)
- 403v. SUPERVISED FIELD WORK (6)
- 408v. OCCUPATIONS (3)
- 409v. TESTS AND MEASUREMENTS (3)
- 412v. SPECIAL PROBLEMS IN VOCATIONAL EDUCATION (4)
- 415v. PROBLEMS IN CO-ORDINATING VOCATIONAL EDUCATION (3)
- 420v. OCCUPATIONAL HYGIENE (3)
- 427v. ADVANCED COURSE OF STUDY BUILDING (3)
- 446v. IMPROVEMENT OF INSTRUCTION IN VOCATIONAL EDUCATION (4)
- 450v. SHOP LAYOUT AND MANAGEMENT (3)
- 501v. SEMINAR IN VOCATIONAL EDUCATION (6) Conferences, investigations, and discussion for advanced students and mature persons who have had experience as teachers, supervisors, or administrators.
- 506v. ADMINISTRATION OF VOCATIONAL EDUCATION (3) The job of the local director of industrial education in organizing and developing city and other local programs of industrial education. Prerequisite: 6 credits in industrial education, valid director's certificate, or equivalent training and experience.
- 510v. VOCATIONAL EDUCATION FOR ADMINISTRATORS (3) Designed for school administrators and supervisors who desire an understanding of practical arts and vocational education. Prerequisite: I.Ed. 1v or trade or teaching experience.

## INDUSTRIAL ARTS EDUCATION

550v. RESEARCH IN VOCATIONAL EDUCATION (3) Research techniques in vocational industrial education.

558v. EMERGING PROBLEMS IN INDUSTRIAL AND TECHNICAL EDUCATION (2-3 per unit)

*Unit A. Federal Legislation* (2-3) Recent federal legislative activities and executive orders that bear directly and indirectly upon industrial education.

*Unit B. Present-Day Local, Personnel, and Curriculum Problems* (2-3) Various plans, techniques, and practices.

*Unit C. State and Local Supervision and Administration* (2-3) The more important recent problems in organization, supervision, and administration.

*Unit D. Vocational Technical Education* (2-3) Problems of organization and administration of programs of technical education at the secondary and post-secondary levels. Prerequisite: 6 credits in industrial education, valid director's certificate, or equivalent training and experience.

560v. PHILOSOPHY OF INDUSTRIAL EDUCATION (3) Principles and beliefs of progressive industrial education; literature for evaluating instructional practices. Prerequisite: 12 credits in industrial education or teaching experience.

## INDUSTRIAL ENGINEERING

BENJAMIN W. NIEBEL, *Head of the Department*  
203 Engineering C

*Degrees Conferred:* M.S., M.Eng.

*Graduate Faculty:* Professors Niebel, Thuring, Draper, and Raphael.

Graduate study and research are conducted in operations research, linear programming, queuing theory, and experimental design. Opportunities also exist for advanced study in automation, production engineering, product design for production, work measurement, costs and budgets, tool design, methods analysis, personnel management, and management controls.

For admission a student must have graduated from an accredited school with a major in industrial engineering. Graduates of other accredited engineering curriculums may be admitted after completing 27 credits in industrial engineering.

### INDUSTRIAL ENGINEERING (I E)

400. ENGINEERING FOR PRODUCTION (3)	Mr. Niebel
402. ENGINEERING ECONOMY (3)	Messrs. Niebel, Raphael, and Thuring
404. MANAGEMENT SCIENCE (3)	Messrs. Caldwell and Raphael
406. FACTORY PLANNING (2)	Messrs. Thuring, Draper, and Olsen
422a,b,c,d,e,f. INDUSTRIAL ENGINEERING PROBLEMS (2-12)	Messrs. Niebel, Thuring, and Moss
423. QUALITY CONTROL (2)	Mr. Thuring
424. JOB EVALUATION (3)	
425. METHODS OF INDUSTRIAL OPERATIONS RESEARCH (3)	Mr. Guild
426. INDUSTRIAL AUTOMATION (3)	Mr. Bowman
427. ADVANCED METAL CASTING (3)	Mr. Draper
428. FOUNDRY ENGINEERING (3)	Mr. Draper



## INDUSTRIAL ENGINEERING

429. PLASTIC WORKING OF METALS (3) Mr. Bowman  
430. INDUSTRIAL LEADERSHIP (3) Mr. Caldwell  
432. INDUSTRIAL ENGINEERING LECTURES (1-3)  
  
501. MANUFACTURING METHODS (2-8) Special projects including investigation; experimentation, design, and research of one or more special types of manufacture. Messrs. Niebel and Thuerling  
502. MANAGEMENT METHODS (3-6) Scientific management, including management controls and mathematical programming; research on special problems. Messrs. Thuerling and Niebel  
503. PERSONNEL RELATIONS (2-8) Research on special topics. Mr. Williamson  
505. GRAPHICAL COMPUTATION (2-6) Construction of natural and logarithmic scales, applications of various co-ordinate papers and construction of nomographic or alignment charts; determination of empirical formulae from engineering data. Mr. Thuerling  
506. TIME AND MOTION STUDY (3-9) Methods of research in motion and time study; critical analysis of current literature. Mr. Niebel  
507. BUDGETARY CONTROL AND STANDARD COSTS (3-6) Divisional budgets as control media; establishing standard cost data, standard cost accounting procedures, and use of cost variances in controlling manufacturing operations. Prerequisite: I.E. 335.  
513. DATA PROCESSING AND PROGRAMMING (3) Theory and techniques in systems analyses applied to the programming of procedures and operations.

## JOURNALISM

ROBERT M. POCKRASS, *Chairman of the Graduate Program*  
110 Carnegie Building

*Degree Conferred:* M.A.

*Graduate Faculty:* Professors Brown, Marbut, and Markham; Associate Professors Froke, Hicks, and Pockrass; Assistant Professor Norris.

The program is designed to give students a critical insight into the theory and practice of communication and the mass communications industries, as well as an introduction to research on communications problems. Fulfilling the requirements for this degree should qualify students to advance in positions of responsibility and leadership in the professions of journalism, advertising, broadcasting, and public relations; in communications research; or in education.

The program is designed for students who have a groundwork of technical and professional education or experience in journalism and communications. Such students are admitted under Plan A. Students lacking a knowledge of the fundamentals of journalism and communications may enroll under Plan B and be required to take up to 18 credits in basic courses needed to make up this deficiency.

### JOURNALISM (JOURN)

401. CRITICS AND ETHICS OF THE MASS MEDIA (2)  
405. COMPARATIVE FOREIGN JOURNALISM (2)  
421. EDITORIAL INTERPRETATION (3)

424. PUBLIC AFFAIRS REPORTING (4) *Mr. Dulaney*  
 430. JOURNALISM IN THE SCHOOLS (3-6) *Mr. Vairo*  
 441. ADVANCED ADVERTISING COPYWRITING (3)  
 443. ADVERTISING CAMPAIGNS (3)  
 444. ADVERTISING IN CONTEMPORARY SOCIETY (3) *Mr. Norris*  
 466. PUBLIC RELATIONS PROBLEMS (3) *Mr. Vairo*  
 468. LAW OF MASS COMMUNICATIONS (3) *Messrs. Marbut and Markham*  
 480. MEDIA MANAGEMENT (3) *Mr. Markham*  
 492. ADVANCED TELEVISION NEWS (3) *Mr. Froke*  
 499. INDEPENDENT STUDY IN MASS COMMUNICATIONS (2-6) *Mr. Goodwin*
504. SEMINAR IN THE HISTORY OF MASS COMMUNICATION (3) *Mr. Marbut*
505. INTERNATIONAL COMMUNICATION PROBLEMS (3-6) Legal and communications problems of the international flow of news and opinion; international press codes. *Mr. Markham*
506. SEMINAR IN COMMUNICATIONS RESEARCH (3-6) Methodology of research in media, content, audiences; experimental, case, and field studies; data processing and analysis; report writing; individual projects. *Mr. Markham*
508. THE LITERATURE OF JOURNALISM (3) *Mr. Brown*
513. CURRENT PROBLEMS IN NEWS REPORTING AND EDITING (3) Securing, writing, display, and treatment of the news; newsroom policies and ethics. *Mr. Marbut*
521. NEWS MEDIA AND PUBLIC OPINION (3) Problems in the function, techniques, and responsibilities of press, radio, and television in forming and interpreting opinion. Prerequisite: Pl.Sc. 427, Psy. 429, or Soc. 431. *Mr. Pockrass*
540. SEMINAR IN ADVERTISING PROBLEMS (3)

## MATHEMATICS

JAMES B. BARTOO, *Acting Head of the Department*  
 231 McAllister Building

*Degrees Conferred:* Ph.D., D.Ed., M.A., M.Ed.

*Graduate Faculty:* Professors Ayoub, Bartoo, Benton, Cohen, Curry, Orrin Frink, Evan Johnson, Krall, Mitchell, Schoenfeld, and Sheffer; Associate Professors Faith, Aline Frink, Hostinsky, Kanwal, Mack, Mary McCammon, and Raney; Assistant Professors D. G. Johnson, Kist, Pervin, and Pour-El.

Graduate courses in all the principal branches of mathematics are offered each year. The department is prepared to direct research in a variety of fields, including function theory, abstract algebra, topology, number theory, statistics, numerical analysis, and all aspects of mathematical logic and foundations. A digital computer is available on the campus for students interested in numerical methods.

To be admitted to the M.A. or Ph.D. program without undergraduate deficiency, an applicant should have completed at least 3 courses in mathematics at the advanced undergraduate level (400 series) or their equivalents. The undergraduate student is urged to take at least 6 credits in foundations of analysis (Math. 420-421) and 6 in modern algebra (Math. 480-481) or their equivalents. These courses are essential to prepare for the graduate program and, if they are taken after admission, only 6 credits at most may be counted toward an advanced degree.

## MATHEMATICS

To be admitted to the M.Ed. program without undergraduate deficiency in mathematics, an applicant should have at least 24 credits in mathematics including at least 6 at the intermediate level beyond calculus.

### MATHEMATICS (MATH)

- 403. MODERN METHODS IN GEOMETRY (3)
- 404. THEORY OF NUMBERS (3)
- 405. FOURIER SERIES AND BOUNDARY VALUE PROBLEMS (3)
- 407. FOUNDATIONS OF ALGEBRA AND GEOMETRY (3)
- 409-410. PROBABILITY AND STATISTICS (3 each)
- 411. FINITE DIFFERENCES (3)
- 412. ALGEBRAIC EQUATIONS (3)
- 413-414. MATHEMATICS OF SCIENCE FOR TEACHERS (3 each)
- 415. SURVEY OF MODERN MATHEMATICS FOR TEACHERS (3)
- 416. MATHEMATICAL LOGIC FOR TEACHERS (3)
- 417. VECTOR AND TENSOR ANALYSIS (3)
- 419. ANALYTICAL MECHANICS (3)
- 420-421. INTRODUCTION TO ANALYSIS (3 each)
- 428. (Phil. 428) LOGICAL THEORY (3)
- 431. DIFFERENTIAL EQUATIONS (3)
- 441. MATRIX ALGEBRA (3)
- 451-452. INTRODUCTION TO APPLIED MATHEMATICS (3-6 each)
- 453. MATHEMATICS FOR DIGITAL COMPUTERS (3)
- 472. FOUNDATIONS OF GEOMETRY (3)
- 473. ELEMENTS OF SET THEORY AND TOPOLOGY (3)
- 480-481. INTRODUCTION TO MODERN ALGEBRA (3 each)
- 491. TOPICS IN APPLIED MATHEMATICS (3-9)
  
- 500. ANALYTICAL MECHANICS (3) An exposition of rigid dynamics, the potential function, and Lagrange's equations. Prerequisite: Math. 419 or Phys. 461.
- 501-502. THEORY OF FUNCTIONS OF A REAL VARIABLE (3 each) Theory of real functions, sets, measure, derivatives, and integrals. Prerequisite: Math. 420.
- 503. FOURIER ANALYSIS (3) Fourier series and integrals, convergence and summability, theorems on Fourier coefficients, uniqueness properties. Prerequisite or concurrent: Math. 502.
- 505. INTEGRAL EQUATIONS (3) Fredholm and Volterra equations, and applications. Prerequisite: Math. 421.
- 507. CALCULUS OF VARIATIONS (3) Prerequisites: Math. 44, 421.
- 508-509. THEORY OF FUNCTIONS OF A COMPLEX VARIABLE (3 each) Development of the complex number system; theory of analytic functions. Prerequisite: Math. 421.
- 510. THEORY OF GROUPS (3) Selected topics from group theory including Abelian, solvable, nilpotent, and free groups, Sylow theorems, and group extensions and representations. Prerequisite: Math. 535.
- 511. LINEAR ALGEBRA (3) Vector spaces and linear transformations, canonical representations, elementary divisors and invariant factors. Prerequisites: Math. 480, 441; or Math. 481.
- 513-514. ADVANCED ANALYTIC GEOMETRY (3 each) Introduction of homogeneous coordinates and their use in the study of projective properties. Prerequisite: Math. 43.



515. **PARTIAL DIFFERENTIAL EQUATIONS OF MATHEMATICAL PHYSICS (3)** Methods of solution of selected elliptic, parabolic, and hyperbolic partial differential equations, with reference to physical application. Prerequisite: Math. 421.
- 516-517. **THEORY OF PROBABILITY (3 each)** Sample spaces, combinatorial analysis, limit theorems, random walk, Markov chains, stochastic processes. Prerequisite: Math. 420.
- 520-521. **PROJECTIVE GEOMETRY (3 each)** General study of the subject from the postulational standpoint. Prerequisite: Math. 43. Alternate years or as required.
- 522-523. **METRIC DIFFERENTIAL GEOMETRY (3 each)** The usual classical treatment of the subject. Prerequisite: Math. 43.
- 530-531. **TOPOLOGY (3 each)** Topological spaces, combinatorial topology, applications to algebra and analysis.
532. **THEORY OF SETS (3)** Formal development of set theory on a logical basis and related methodological problems; applications to the foundations of mathematics. Prerequisite: Math. (Phil.) 428.
534. **THEORY OF ALGEBRAIC NUMBERS (3)** Introduction to the number theory of quadratic fields, with study of the theory of ideals in quadratic and higher fields, with application. Prerequisites: Math. 404, 480.
535. **MODERN ALGEBRA (3)** First graduate course in abstract algebra including the basic theory of semigroups, rings, fields, operator groups, and factorization. Prerequisites: Math. 480, 441; or Math. 481.
537. **THEORY OF FIELDS (3)** Selected topics from field theory including extensions and structure of fields; Galois theory; algebraically closed, ordered, and algebraic number fields. Prerequisite: Math. 535.
538. **THEORY OF RINGS (3)** Selected topics from commutative and noncommutative ring theory including ideals, the Jacobson structure theory, and special classes of rings. Prerequisite: Math. 535.
539. **LATTICE THEORY (3)** Selected topics from lattice theory including complete, modular, complemented, and distributive lattices and applications. Prerequisite: Math. 535.
- 542-543. **THEORY OF STATISTICS (3 each)** Univariate and multivariate distributions, sampling distributions, theory of estimation, statistical hypotheses. Prerequisites: Math. 409, 421.
- 550-551. (Phil. 550-551) **FOUNDATIONS OF MATHEMATICAL LOGIC (3 each)** The nature of logical basis of mathematics; critical examination and development of the basic parts of logical calculus. Prerequisite: Math. 480 or Math. (Phil.) 428.
- 552-553. **NUMERICAL METHODS (3 each)** Procedures for practical calculation, including interpolation, solution of equations, iterative methods, harmonic analysis, and use of modern calculating equipment. Prerequisite: Math. 420.
554. (Phil. 554) **METAMATHEMATICS (3)** Prooftheoretic and modeltheoretic study of systems: Gödel's theorem, relative and absolute consistency proofs, decidability, properties of relational structures, mathematical applications. Prerequisite: Math. (Phil.) 428.
555. **SELECTED TOPICS IN MATHEMATICS FOR CHEMISTS (3)** An introduction to matrices, groups, group representations, characters, and orthogonal functions.

## MATHEMATICS

556. (Phil. 556) RECURSION THEORY (3) Recursive functions; recursive and recursively enumerable sets; equivalent formulations of computability; Church's thesis; related topics from current literature. Prerequisite: Math. (Phil.) 428.
- 560-561. THEORY OF DIFFERENTIAL EQUATIONS (3 each) Prerequisites: Math. 44, 421.
565. FUNCTIONAL ANALYSIS (3) Theory of Banach and Hilbert spaces, including functionals and operators, and related topics. Prerequisite: Math. 420.
570. SPECIAL TOPICS IN GEOMETRY (3-6)
571. SPECIAL TOPICS IN ANALYSIS (3-6)
572. SPECIAL TOPICS IN ALGEBRA (3-6)
573. SPECIAL TOPICS IN APPLIED MATHEMATICS (3-6)
574. SPECIAL TOPICS IN FOUNDATIONS OF MATHEMATICS (3-6)
- 575-576. MATHEMATICS SEMINAR (1-6 each) Selected topics from recent mathematical developments.

## MECHANICAL ENGINEERING

MAURICE S. GJESDAHL, *Head of the Department*  
207 Mechanical Engineering Building

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Professors Ambrosius, DiIlio, Gjesdahl, Hussmann, and Meyer; Associate Professors Brickman and Lester.

Graduate programs in mechanical engineering emphasize heat power or machine design. Courses and facilities permit studies in heat transfer, advanced machine design, internal combustion engines, machine dynamics, gas turbines and gas dynamics, lubrication, automatic control systems, and power generation and utilization.

To be admitted, a student should be a graduate of an accredited curriculum in mechanical engineering. Graduates of other accredited engineering or physical science curriculums may be admitted, but will be required to make up undergraduate deficiencies without graduate credit.

### MECHANICAL ENGINEERING (M E)

- 401a,b,c,d. MECHANICAL ENGINEERING (3-12)
402. AIR CONDITIONING (3)
403. ROCKET PROPULSION (3)
409. GAS TURBINES (3)
410. POWER PLANTS (3)
411. REFRIGERATION (3)
412. HEAT TRANSFER (3)
413. INTERNAL COMBUSTION ENGINES (3)
417. THEORY OF ENGINEERING INSTRUMENTS (3)
418. PRINCIPLES OF TURBOMACHINERY (3)
450. DESIGN OF MACHINE TOOLS (3)
451. ADVANCED MACHINE DESIGN PROBLEMS (3)
452. MACHINE DESIGN ANALYSIS (3)
453. BEARING DESIGN AND LUBRICATION (3)

## MECHANICAL ENGINEERING

455. AUTOMATIC CONTROL SYSTEMS (3)
457. ADVANCED MECHANISMS (3)
502. ADVANCED GAS TURBINES (3-6) Analytical study of gas turbine compressors and turbines; combustion; complex cycles; recent developments. Prerequisite: M.E. 409.
504. ADVANCED ENGINEERING THERMODYNAMICS (3-6) Pure and applied thermodynamics including its application to advanced engineering problems; collateral reading and discussion of the classical works on the subject. Prerequisite: M.E. 32.
505. HEAT TRANSMISSION (3-6) Applications of principles of heat transfer to efficient design of mechanical engineering equipment. Prerequisite: M.E. 412.
506. SELECTED TOPICS IN MECHANICAL ENGINEERING (1-12) Advanced courses adapted to the individual requirements of graduates in mechanical engineering.
518. TURBOMACHINERY (3) Similarity considerations and basic equations of turbomachinery; limiting flow conditions; theory and design of vane systems; special topics.
519. COMPRESSIBLE FLUID FLOW (2-4) Two-dimensional subsonic flow; similarity rules; theory of characteristics; two-dimensional supersonic flow; oblique shock waves.
520. NONSTEADY FLOW OF COMPRESSIBLE FLUIDS (2-4) Method of characteristics; general flow problems; boundaries and discontinuities; interaction of discontinuities; wave diagram techniques and applications.
550. ANALYSIS OF DESIGN PROBLEMS (3) Case problems in machine design requiring integrated application of engineering knowledge.
552. ADVANCED DYNAMICS OF MACHINES (3-6) Linear and torsional vibrations in and balancing of rotating and reciprocating machinery; exact analysis of stresses produced by these and other dynamic forces in machine parts. Prerequisites: E.Mch. 12, M.E. 54.
553. FRICTION AND LUBRICATION (3) The hydrodynamic theory of lubrication and methods of applying it to bearing design, together with a survey of methods of testing lubricants.
555. AUTOMATIC CONTROL SYSTEMS (3) Advanced problems and techniques in the design of automatic control systems with emphasis on stability, controller design, and optimum performance. Prerequisite: M.E. 455.
557. MECHANISM SYNTHESIS (3) Design and analysis of mechanisms for specific motion and energy requirements; intermittent mechanisms. Prerequisite: M.E. 457.
580. INVESTIGATION PROJECTS (2-6) Special experimental studies or investigations in mechanical engineering, adapted to individual requirements.

## METALLURGY

ROBERT W. LINDSAY, *Head of the Department*  
5 Mineral Sciences Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Davis, Lindsay, and Read; Associate Professor Muan; Assistant Professors Hoke and Ryba.



## METALLURGY

There is opportunity for a student to specialize, both in research and in course work, in chemical metallurgy, physical metallurgy, mechanical metallurgy, or the science of metals. Minor work in any of these specializations is available for students majoring in another field.

The requirements for admission are a satisfactory bachelor's degree in metallurgy, metallurgical engineering, chemistry, chemical engineering, physics, mechanical engineering, or engineering mechanics; or a satisfactory bachelor's degree in another field, provided it has included the equivalents of mathematics through integral calculus; 8 credits of physics; 12 of chemistry; 10 of other scientific, engineering, or mineral science fields; and 10 of metallurgy. Students who lack some of these requirements may be admitted but are required to take the prerequisite courses without being able to apply them toward an advanced degree.

### METALLURGY (METAL)

- 405. FERROUS METALLOGRAPHY (3)
- 406. NONFERROUS METALLOGRAPHY (3)
- 407. METALLURGICAL ENGINEERING I (2)
- 408. METALLURGICAL ENGINEERING II (3)
- 409. METALLURGICAL INVESTIGATIONS I (2)
- 410. METALLURGICAL INVESTIGATIONS II (2)
- 412. SOLID STATE METALLURGY (3)
  
- 501. METALLURGICAL PROBLEMS (1-6 per term) Independent study of special problems in metallurgy.
- 502. SEMINAR IN METALLURGY (1-6) Conferences, reading, reports, and special lectures.
- 505. NUCLEAR REACTOR MATERIALS (3) Extractive metallurgy, alloy theory, transformations, physical properties, mechanical behavior, and corrosion of principal reactor materials; radiation damage; fuel element manufacture. Prerequisites: Metal. 59, E.Mch. 13.
- 511. ADVANCED PHYSICAL METALLURGY (3) Physical metallurgy of an advanced nature; consideration of solid state bonding, crystal structure, alloy constitution, atom movements. Prerequisites: Chem. 452, Metal. 303, 412. *Mr. Ryba*
- 513. ADVANCED CHEMICAL METALLURGY (3) Application of thermodynamics and kinetics to the heterogeneous metallurgical processes of oxidation, reduction, smelting, and refining. Prerequisites: Chem. 452, Metal. 301, 302, 304. *Mr. Davis*
- 515. CORROSION OF METALS (3) Phenomena and theories of metallic corrosion; principles of alloy selection for engineering and structural uses in corrosive environments. Prerequisites: Metal. 511, 513. *Mr. Read*
- 516. FLOW AND FRACTURE OF SOLIDS (3) Phenomenological and theoretical treatment of flow and fracture in solids. Prerequisites: Metal. 511, 513. *Mr. Hoke*
- 518. CONSTITUTION OF METALLURGICAL SYSTEMS (3) Application of thermodynamic principles to study of heterogeneous equilibrium in alloy, slag, and slag-metal systems. Prerequisites: Metal. 511, 513. *Mr. Davis*
- 519. ADVANCED FERROUS METALLURGY (3) Physicochemical principles applied to reactions in iron- and steelmaking systems, including gas, metal, slag, and refractory phases. Prerequisite: Chem. 452 or Metal. 513. *Mr. Muan*
- 520. FOUNDRY METALLURGY (3) Physical-chemical considerations of the liquid state, solidification, and the solid state as applied to casting of metals and alloys. Prerequisites: Metal. 511, 513. *Mr. Lindsay*

522. SOLID-PHASE REACTIONS IN METALS (3) Mechanisms and rate determining factors in solid-phase reactions in metals; diffusion processes, nucleation theory, precipitations from solid solution, eutectoid decomposition and order-disorder phenomena. Prerequisites: Metal. 511, 513. *Mr. Ryba*

524. ADVANCED METAL WORKING (3) Elements of mathematical theory of plasticity; metal working processes; measurement of deformations in metal working; theory of metal working. Prerequisite: Metal. 516. *Mr. Hoke*

525. METAL FINISHING (3) Metallic coatings and their metallurgical properties; theories and problems of application, utilization, and evaluation. Prerequisite: Metal. 515. *Mr. Read*

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in metallurgical studies are listed under Mineral Sciences in Part II of this bulletin.

## METEOROLOGY

CHARLES L. HOSLER, JR., *Head of the Department*  
322 Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Blackadar, Hosler, Neuberger, and Panofsky; Associate Professor Stephens.

Candidates in meteorology may specialize in aerosol and cloud physics, various phases of dynamic meteorology including turbulence and atmospheric circulation, atmospheric optics and electricity, macro- and microclimatology, agricultural meteorology, synoptic meteorology, or meteorological instrumentation.

Requirements for admission include mathematics through differential equations, one year of college physics, and 12 credits in meteorology. Students with a strong background in mathematics, physics, or engineering may be admitted with deficiencies but must make up such deficiencies before they are admitted to candidacy for a degree.

### METEOROLOGY (METEO)

- 400. METEOROLOGY FOR TEACHERS (3)
- 411. INTRODUCTION TO SYNOPTIC METEOROLOGY (3)
- 412. SYNOPTIC METEOROLOGY (3)
- 418. INTRODUCTORY PHYSICS OF THE UPPER ATMOSPHERE (3)
- 420. TROPICAL METEOROLOGY (3)
- 430. INTRODUCTION TO SYNOPTIC METEOROLOGY LABORATORY (3)
- 431. SYNOPTIC METEOROLOGY LABORATORY I (3)
- 432. SYNOPTIC METEOROLOGY LABORATORY II (2-10)
- 433. ADVANCED SYNOPTIC ANALYTICAL TECHNIQUES (3)
- 443. PHYSICAL METEOROLOGY (3)
- 445. HYDROMETEOROLOGY (3)
- 450. APPLICATIONS OF STATISTICS TO METEOROLOGY (3)
- 451. THERMODYNAMICS OF THE ATMOSPHERE (3)
- 452. HYDRODYNAMICS OF THE ATMOSPHERE (3)
- 461. THEORY OF METEOROLOGICAL INSTRUMENTS (3)
- 472. PHYSICAL AND DYNAMIC CLIMATOLOGY (3)
- 492. METEOROLOGICAL SEMINAR (1-2)



## METEOROLOGY

500. METEOROLOGICAL SEMINAR (1-3) Discussion of meteorological reports and papers; scientific outlook. Prerequisites: Meteo. 412, 451.
502. SELECTED TOPICS OF ADVANCED METEOROLOGY (2) Current problems in meteorology. Prerequisite: a minimum of 15 credits in meteorology.
503. ATMOSPHERIC TURBULENCE (3) Atmospheric diffusion, heat conduction, friction, and evaporation; statistical properties of turbulence.
505. BIOCLIMATOLOGY (2) Climatic phenomena in their relation to life. Prerequisite: Meteo. 472.
506. ADVANCED METEOROLOGICAL ANALYSIS (2-6) Physical analysis of atmospheric phenomena; synoptic analysis of weather phenomena for advanced students. Prerequisite: Meteo. 412.
507. DYNAMIC OCEANOGRAPHY (2) Physical properties of sea water; heat balance of the oceans; theory and observations of ocean currents, waves, and tides.
508. PHYSICS OF THE UPPER ATMOSPHERE (2) Temperature distribution, composition, and electrical characteristics of the upper atmosphere; theories of aurora and light of the night sky.
509. THEORETICAL CLIMATOLOGY (2) Theory of latitudinal, annual, and diurnal temperature changes; theories of climatic changes; microclimate.
510. CLOUD PHYSICS (2) Current theories on phase changes in clouds and mechanisms responsible for precipitation; techniques of cloud modification and control.
551. ATMOSPHERIC WAVE MOTION (2) From classical and physical hydrodynamics to the numerical prediction of wave motion in a baroclinic atmosphere. Prerequisite: Meteo. 452.
552. ADVANCED ATMOSPHERIC DYNAMICS (2) Numerical prediction models, general circulation, thermal and gravitational tides in a spherical shell, and empirical orthogonal functions of statistical forecasting. Prerequisite: Meteo. 551.

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in meteorological studies are listed under Mineral Sciences in Part II of this bulletin.*

## MINERAL ECONOMICS

JOHN D. RIDGE, *Head of the Department*  
207 Mineral Sciences Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professor Ridge; Associate Professor Schanz; Assistant Professor McDivitt.

A student may specialize in the economics of exploration for, and the extraction, beneficiation, and utilization of, the ferrous and nonferrous metals, the nonmetallics, the fuels, and ground water. Work is also offered in property evaluation, analysis of mineral data, and the influence of technological advances on mineral economics.

The requirements for admission are 24 credits in chemistry, physics, and mathematics; 12 in geology, mineralogy, and/or the biological sciences; 9 in mineral economics, economics, commerce, and/or geography; and 6 in mining, metallurgy, petroleum engineering, ceramics, and/or industrial engineering.



## MINERAL ECONOMICS

Students having a deficiency of 9 credits or fewer in this total of 51 may be admitted as regular graduate students but will be required to make up such deficiencies without the credits being applicable toward the advanced degree.

### MINERAL ECONOMICS (MN EC)

- 400. SEMINAR (1)
- 453. NONMETALLIC MINERALS (3)
- 483. THE METALS AND THEIR ORES (3)
- 484. THE SOLID FUELS (3)
- 486. PETROLEUM AND NATURAL GAS ECONOMICS (3)
- 490. MINERAL VALUATION (3)
- 491. ANALYSIS OF MINERAL DATA (2)
  
- 500. ADVANCED PRINCIPLES OF MINERAL ECONOMICS (3-6) Economic history of mineral industries, research methods, economics of mineral exploitation and utilization, mineral policy.
- 501. RESEARCH IN MINERAL ECONOMICS (3-6) Investigation in specialized fields of research in mineral economics. Prerequisite: 3 credits in Mn.Ec. 500.
- 502. TECHNOLOGIC INFLUENCES (3-9) Relationship of technologic advancements to economic development of the mineral industries. Prerequisite: 3 credits in Mn.Ec. 500.
- 505. PROBLEMS OF MINERAL ECONOMICS (3-12) Determination of basic technologic-economic patterns of selected mineral industries. Prerequisite: 3 credits in Mn.Ec. 500.

## MINERAL PREPARATION

H. BEECHER CHARMBURY, *Head of the Department*  
4 Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Charmbury, Spicer, and Sun; Assistant Professor Lovell.

Areas in which students may specialize include the fundamentals of gravity, electrical, and chemical methods of beneficiating natural mineral deposits. Graduate work may also be undertaken on the properties of specific minerals as they are related to beneficiation.

Graduates with a bachelor's degree in such scientific fields as chemistry, physics, and mathematics, and in such engineering fields as mining, metallurgy, ceramics, fuel technology, and mechanical, electrical, and civil engineering are eligible for admission. However, graduates in the above fields are required to take 6 credits of undergraduate courses in mineral preparation along with their graduate program.

### MINERAL PREPARATION (MN PR)

- 400. MINERAL PREPARATION SEMINAR (1)
- 401. ADVANCED MINERAL PREPARATION LABORATORY (1)
- 410. COAL PREPARATION (3)
- 420. UNIT OPERATIONS (3)
- 430. FLOWSHEETS OF MINERAL PREPARATION PLANTS (3)
- 457. FIELD TRIP (1-2)

## MINERAL PREPARATION

502. FROTH FLOTATION AND AGGLOMERATION (3) Intensive study of theory and applications of froth flotation and agglomeration. Prerequisite: Mn.Pr. 420.  
Mr. Sun
504. MINERAL PREPARATION RESEARCH (1-6 per term) Research work on specific problems in mineral preparation. Prerequisite: Mn.Pr. 410 or 420.  
Mr. Charmbury and Staff
505. GRAVITY PROCESSES AND MISCELLANEOUS METHODS OF MINERAL PREPARATION (3) Intensive study of theory and applications of gravity, magnetic, electrostatic, centrifugal, and dense-media processes of mineral concentration. Prerequisite: Mn.Pr. 420.  
Mr. Spicer
506. MINERAL PREPARATION PLANT DESIGN (3-10) Layout, design, and selection of equipment for specific mineral preparation plant projects. Prerequisite: Mn.Pr. 420.  
Mr. Spicer
507. CHEMICAL PROCESSES OF MINERAL PREPARATION (3) Practice and theory of methods to upgrade ores by chemical treatment including roasting, solubility separations, surface phenomena, and reactions. Prerequisite: Mn.Pr. 420. Mr. Lovell
- NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in mineral preparation studies are listed under Mineral Sciences in Part II of this bulletin.

## MINERALOGY AND PETROLOGY

JOHN C. GRIFFITHS, *Head of the Department of Mineralogy*  
114 Mineral Sciences Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Bates, Griffiths, and Krynine; Associate Professor Wright.

Areas of specialization include igneous, sedimentary, and metamorphic petrology, mineralogy, crystal chemistry, X-ray mineralogy, clay mineralogy, ore mineralogy, and applications of statistics in the earth sciences.

The general requirements for admission are mathematics through integral calculus, chemistry through quantitative analysis, 10 credits of general physics, 30 credits of geology, petrology, and mineralogy including microscopical petrography (i.e., an equivalent to G.Sc. 485, acceptable to the faculty).

Additional specific requirements must be fulfilled in most areas of specialization. Deficiencies may, in most cases, be made up after admission.

### GEOLOGICAL SCIENCES (G SC)

- |                             |               |
|-----------------------------|---------------|
| 463. OPTICAL MINERALOGY (2) | Mr. Wright    |
| 464. OPTICAL MINERALOGY (1) | Mr. Wright    |
| 483. PETROLOGY (2)          | Mr. Griffiths |
| 484. PETROLOGY (2)          | Mr. Griffiths |
| 485. PETROLOGY (2)          | Mr. Griffiths |

### MINERALOGY (MIN)

500. OPTICAL CRYSTALLOGRAPHY OF MINERALS (3) Optical methods, microscopic techniques, and measurement of optical constants of crystals; theory and application of the universal stage. Prerequisite: G.Sc. 464.  
Mr. Wright

## MINERALOGY AND PETROLOGY

501. PETROLOGY (3-6) Microscopic study of rocks, emphasizing classification and genetic relationships. *Messrs. Krynine, Tuttle, and Griffiths*
502. MINERALOGICAL PROBLEMS (3) Original study of some limited mineralogical or petrological problems.
504. THEORETICAL MINERALOGY (3) Crystal chemistry and crystal physics applied to solid solution, polymorphism, crystal growth, and related phenomena. *Mr. Bates*
505. MINERALOGY SEMINAR (1-2) Reading, presentation, and discussion of literature dealing with various phases of theoretical mineralogy. Topics are selected to meet the interests of the majority of the students. *Messrs. Krynine, Tuttle, Bates, Griffiths, and Brindley*
- \*510. METAMORPHIC PETROLOGY (2-6) Detailed Review of chemical, mineralogical, and structural changes that take place during metamorphism. Prerequisites: G.Sc. 483, 484, 485.
511. SEDIMENTARY PETROLOGY (3-4) Composition, texture, structure, mass properties of sediments; dynamic processes in complex natural systems; sedimentary stages: weathering, erosion, transport, deposition, and lithification. Prerequisites: G.Sc. 483, 484, 485. Concurrent: Min. 513. *Mr. Krynine*
512. SEDIMENTARY PETROLOGY, CONTINUED (2-4) Diastrophism and tectonic background of sedimentation; depositional loci; classification of sediments: quartzites, graywackes, arkoses; chemical sediments; paleogeography, paleoclimatology, oil finding. Prerequisite: Min. 511. Concurrent: Min. 514. *Mr. Krynine*
513. METHODS OF ANALYSIS OF SEDIMENTS (3) Principles and practices used in analyzing sedimentary rocks for size, shape, and accessory (heavy) minerals. Concurrent: Min. 511. *Mr. Griffiths*
514. APPLIED SEDIMENTOLOGY (3) Design and control in analysis of sedimentary rocks; application of these techniques to industrial problems. Concurrent: Min. 512. *Mr. Griffiths*
- †517. SEDIMENTS OF THE WORLD (1-9) Microscopic and field studies of representative American and foreign rock suites; correlation with paleogeographic, geotectonic, economic data. Prerequisites: Min. 512, 514. *Mr. Krynine*
520. STUDY OF ACCESSORY MINERALS (2-4) Detailed study of accessory (heavy) minerals; their significance in problems of provenance, petrogenesis, mineral stratigraphy, and paleogeography. Prerequisites: Min. 511, 512, 513, 514. *Mr. Griffiths*
524. INTRODUCTION TO SEDIMENTATION (3) Prerequisites: G.Sc. 483, 484. Concurrent: G.Sc. 485. *Mr. Krynine*
525. IGNEOUS PETROLOGY (2-6) Origin, distribution, and composition of igneous rocks. Prerequisites: G.G. 513; G.Sc. 483, 484, 485; Min. 500, 527. *Mr. Tuttle*
526. STATISTICAL PROBLEMS IN SEDIMENTARY GEOLOGY (3) Application of experimental design, sampling procedures, multiple regression and discriminant analysis in solving problems in sedimentary petrography. Prerequisites: Min. 514; Math. 410 or Agro. 545. *Mr. Griffiths*
527. IGNEOUS AND METAMORPHIC MINERALOGY (3) Structural and compositional variations of minerals in igneous and metamorphic rocks.

\*Credits to be arranged, 2-4 per term.

†Credits to be arranged, 1-3 per term.



## MINERALOGY AND PETROLOGY

528. MINERALOGICAL CRYSTALLOGRAPHY (2-3) Application of X-ray and morphological crystallography to mineralogy and petrology.

529. RADIOACTIVITY IN ROCKS (1-2)

Mr. Wright

530. (Cer.T. 530) STRUCTURE, PROPERTIES, AND OCCURRENCE OF CLAY MINERALS (2-5) Structure analysis and identification of clay minerals; mineral transformations and behavior; occurrence, genesis, and petrography of fine-grained sediments.

Messrs. Griffiths, Bates, and Brindley

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in mineralogical studies are listed under Mineral Sciences in Part II of this bulletin.

## MINING ENGINEERING

HOWARD L. HARTMAN, *Head of the Department of Mining*  
305B Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Hartman, Kochanowsky, and Mitchell; Assistant Professor Stefanko.

Areas of specialization which may be followed in research and course work include mine property valuation and economics of mining engineering (ore estimation, cost analysis and control, budgeting), mechanization and mine plant (unit operations, materials handling, continuous mining, power supply), development and exploitation methods (mine planning and layout, design of systems), production engineering and operational analysis (time study, standards, job rating, operations research), environmental control (gas and dust technology, ventilation, air conditioning, hygiene, illumination, safety), and rock mechanics (stress analysis, roof and ground control, penetration, fragmentation).

A bachelor's degree in mining engineering or some related engineering field is required for admission to graduate work. Students may be required to make up deficiencies in their area of specialization. Certain basic, related courses outside the department may be approved as part of the major.

### MINING (MNG)

401. MINE MATERIALS HANDLING (3)

402. MINE POWER (3)

410. MINING ENGINEERING ANALYSIS (2)

411. MINE PRODUCTION ENGINEERING (2)

412. MINE MANAGEMENT (2)

422. MINE VENTILATION AND AIR CONDITIONING (3)

424. MINE SAFETY ENGINEERING (1)

431. ROCK MECHANICS (3)

451-452. ADVANCED MINING ENGINEERING I and II (1 each)

490. SENIOR MINING SEMINAR (1)

513. MINE COST ANALYSIS (3) Nature of mining costs, their analysis and control: depreciation and depletion, capital and operating costs, budgets, records.

514. MINE OPERATIONS ANALYSIS (3) Scientific planning and layout of mining operations based on time studies, mathematical analysis, and proportionality of centroids of reserves. Prerequisites: Math. 100 or 45, Mng. 411.

## MINING ENGINEERING

525. DUST TECHNOLOGY (3) Physical and chemical properties of dusts; airborne dust determinations and analysis; dust control applicable to mills and mines. Prerequisite: Mng. 422.
526. MINE VENTILATION (3) Airflow in mine openings and its control; network solution by mathematics and computer; design of mine and industrial ventilation systems. Prerequisite: Mng. 422.
528. MINE AIR CONDITIONING (3) Thermodynamics of vapor mixtures; heat flow through rock; physiological effects of hot, humid environments; design of temperature-humidity control systems. Prerequisite: Mng. 422.
532. ROCK MECHANICS (3) Behavior of rock under static loading; underground stress instrumentation; experimental stress analysis; design of mine openings; theories of subsidence. Prerequisite: Mng. 431.
541. THEORY OF ROCK PENETRATION (3) Behavior of rock under dynamic loads intended to penetrate; basic energy relations; application of theory to drilling and other penetration. Prerequisites: E.Mch. 13, Mng. 30, Phys. 204.
542. THEORY OF ROCK FRAGMENTATION (3) Behavior of rock under dynamic loads intended to fragment; physical chemistry of explosives; detonation; theory of blasting; design of drill rounds. Prerequisites: E.Mch. 13, Mng. 30, Phys. 204.
580. MINING ENGINEERING RESEARCH (1-3 per term) Supervised research on a specific problem involved in mining science or technology.
590. GRADUATE MINING SEMINAR (1 per term) Preparation and presentation of formal papers on problems of an advanced nature in mining engineering. Required each semester in residence.

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in mining studies are listed under Mineral Sciences in Part II of this bulletin.

## MUSIC

HUMMEL FISHBURN, *Head of the Department*  
217 Carnegie Building

*Degree Conferred:* M.A.

*Graduate Faculty:* Professors Fishburn, Henninger, and Taylor; Associate Professors Ceiga and Karhan; Assistant Professor Brinsmaid.

In his graduate program a student may emphasize one of the following areas, or may elect a program including work in all of them: theory, performance, music literature, and creative music. The minor must be chosen from the liberal arts. Admission to this graduate program requires completion of a recognized music curriculum.

### MUSIC (MUSIC)

407. PIANO LITERATURE (3)  
408. VOCAL LITERATURE (3)  
410. MUSIC OF THE 20TH CENTURY (3)  
411. LITERATURE OF THE VIOLIN (3)  
412. MUSIC OF THE BAROQUE PERIOD (3)

## MUSIC

- \*429. SINGER'S STYLE AND INTERPRETATION (3) Fee \$50.
456. ELEMENTARY COUNTERPOINT (3)
459. MODERN INSTRUMENTAL ARRANGING (3)
466. ADVANCED CONDUCTING (3)
- \*503. ADVANCED STRINGED INSTRUMENTS (3) Study, repertoire building, and recital performance. Fee \$50.
- \*511. ADVANCED PIANO (3) Piano literature of all periods for public performance. Fee \$50.
- \*531. ADVANCED ORGAN (3) Study, repertoire building, and recital performance. Prerequisite: 4 credits of Music 31 and/or 38. Fee \$60.
543. MODERN HARMONY (3) Harmonic writing based on 20th century practices with attention to traditional idioms that serve as foundation.
557. SYMPHONIC STRUCTURE (3) Survey of the evolution and application of the forms used in symphony, sonata, concerto, string quartet, and related works. Prerequisite: Music 57.
- \*558. FREE COMPOSITION (3) Composition: vocal and instrumental, standard or modern idioms. Prerequisite: 18 credits in harmony, counterpoint, and piano.
563. FREE ARRANGING (3) Correct procedure in arranging for vocal and instrumental ensembles; practical exercises in quartets, glee clubs, and choruses; small instrumental groups, band, and orchestra. Prerequisite: 18 credits in harmony, including 3 of orchestration.
567. THE LITERATURE OF THE ORCHESTRA (3) The suite, symphony, tone poem, and overture from the point of view of appreciation, form, and orchestration. Prerequisites: Music 6 and theoretical knowledge of the key instruments of the orchestra.
599. MUSIC SEMINAR (1-3) Seminar in the history, art, and science of music, with readings, discussion, and performance.

## MUSIC EDUCATION

HUMMEL FISHBURN, *Head of the Department*  
217 Carnegie Building

*Degrees Conferred:* D.Ed., M.Ed.

*Graduate Faculty:* Professors Andrews, Dunlop, and Fishburn; Associate Professors Campbell and Karhan.

A student majoring in music education is required to offer a minor in music. However, the master's program must include some work, and the doctoral program considerable work, in the area of general education.

Doctoral students may specialize in vocal, instrumental, or theoretical music in elementary, secondary, or college teaching; but the degree requires work in each of these fields.

For admission to a graduate program a student must have completed a recognized music education curriculum.

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\*May be repeated for a total of 12 credits.



MUSIC EDUCATION (MU ED)

- 446. THE ELEMENTARY MUSIC SPECIALIST (3)
- 462. PEDAGOGY OF THEORY (3)
- 468. THE TEACHING OF PIANO (3)
- 469. BAND AND ORCHESTRA TECHNIQUE (3)
- 470. CHORAL TECHNIQUE (3)
- 475. OBJECTIVES AND PROBLEMS IN ELEMENTARY MUSIC EDUCATION (3)
- 480. CHORAL PROGRAM IN THE SECONDARY SCHOOL (3)
  
- 500. MUSIC EDUCATION SEMINAR (3-6) Problems of various phases of music education, both instrumental and vocal; research and literature dealing with these problems.
  
- 569. PRESENT-DAY TRENDS IN INSTRUMENTAL MUSIC (3) New methods and materials for band, orchestra, and ensembles.
  
- 572. INSTRUMENTAL PEDAGOGY (3-6) Research problems in band and orchestra. Prerequisite: Mu.Ed. 54 or practical experience.
  
- 573. THE MATERIALS OF APPRECIATION (3) Methods and materials for development of music appreciation in elementary and secondary schools. Prerequisites: Music 5, teaching experience.
  
- 574. PRESENT-DAY TRENDS IN MUSIC EDUCATION (3-6) Present-day music education materials and methods (elementary and secondary levels) in relation to modern educational philosophy; emphasis upon practical problems presented by members of the class. Prerequisites: Mu.Ed. 48, teaching experience.
  
- 575. THE JUNIOR HIGH SCHOOL MUSIC CURRICULUM (3) Instructional materials, procedures, curricular and extracurricular activities, integration with other subjects.
  
- 576. MUSIC SUPERVISION (3) Current educational procedures in training music supervisors.
  
- 594. PEDAGOGY OF EAR TRAINING (3) Materials and methods for training the listener to grasp, understand, and write what is heard from melody to four-part harmony. Prerequisite: 12 credits in ear training and/or harmony.

## NUCLEAR ENGINEERING

NUNZIO J. PALLADINO, *Head of the Department*  
231 Sackett Building

*Degrees Conferred:* M.S., M.Eng.

A student may specialize in reactor analysis, reactor heat transfer, reactor structures, nuclear materials, or reactor instrumentation and control. Admission requires a bachelor's degree in engineering or in the physical sciences. Students who have not had appropriate undergraduate courses in modern physics and differential equations will be required to schedule them.

NUCLEAR ENGINEERING (NUC E)

- 410. NUCLEAR ENGINEERING (3)
- 411. NUCLEAR ENGINEERING (3)
- 420. RADIOLOGICAL SAFETY (2)

## NUCLEAR ENGINEERING

501. REACTOR ENGINEERING (3) Reactor controls, shielding of nuclear reactors, stress analysis of reactor materials, power cycle analysis, breeding, and advanced design considerations. Prerequisite or concurrent: Phys. 566.
502. REACTOR ENGINEERING LABORATORY (1-5) Reactor experiments devised to acquaint the student with reactor technology. Prerequisite or concurrent: Phys. 566.
503. THERMONUCLEAR ENGINEERING (3) Binary fusion reactions; microscopic and macroscopic phenomena in a completely ionized gas; electromagnetic confinement; design, operation, and diagnostics of experiments. Prerequisite: Math. 452.
505. REACTOR INSTRUMENTATION AND CONTROL (3) Neutron-detecting instruments and circuits; in-core power instrumentation; reactor control principles; control mechanisms; operational control problems. Prerequisite: Nuc.E. 411.
507. INTERACTION OF RADIATIONS WITH MATTER (2) Theory of the processes by which gamma rays, neutrons, and charged particles interact with electrons, atoms, and nuclei. Prerequisites: Phys. 406; 454 or 456.
508. RADIATION SHIELDING (2) Radiation sources in reactor systems; attenuation of gamma rays and neutrons; deep penetration theories; Monte Carlo methods. Prerequisite: Nuc.E. 507.
509. RADIATION DAMAGE IN SOLIDS (2) Production of defects by high energy particles; nature of defects; diffusion and annealing in solids; macro property changes. Prerequisite: Nuc.E. 507.
550. SPECIAL TOPICS IN NUCLEAR ENGINEERING (1-12) Theoretical studies in nuclear engineering with or without associated experimental work. Prerequisites: Math. 44, Phys. 406.

## PHYSICAL SCIENCE (PH SC)

501. SEMINAR IN NUCLEAR SCIENCE AND ENGINEERING (0)

## PETROLEUM AND NATURAL GAS ENGINEERING

C. DREW STAHL

*Head of the Department of Petroleum and Natural Gas*  
26 Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Nielsen and Slobod; Associate Professors Bissey, Burcik, and Stahl.

Areas of specialization include experimental and theoretical studies of water flooding and the newer methods for displacing oil from porous media, methods for calculating reservoir performance, scaled laboratory studies of reservoir phenomena, and drilling and well completion problems.

Students who expect to enter graduate study in this field with a degree in another curriculum should present 20 credits of chemistry and physics, 6 of geology, 15 of engineering science, and credit for mathematics through integral calculus. A limited number of deficiencies may be made up after admission.

Certain closely related courses outside the department may be counted as petroleum and natural gas credits toward the degree.

PETROLEUM AND NATURAL GAS (P N G)

- 410. APPLIED RESERVOIR ENGINEERING (3)
- 421. RESERVOIR ENGINEERING (3)
- 431. DRILLING FLUIDS (2)
- 450. DRILLING DESIGN AND PRODUCTION ENGINEERING (4)
- 480. PRODUCTION PROCESS ENGINEERING (3)
- 481. NATURAL GAS AND GASOLINE PLANTS (2)
- 485. ENGINEERING IN SECONDARY RECOVERY (3)
- 490. ADVANCED CORE TESTING (3)
  
- 510. FLOW OF HOMOGENEOUS FLUIDS THROUGH POROUS MEDIA (3) Concepts and mathematics describing steady and unsteady state flow in porous media for various initial and boundary conditions.
- \*512. RESERVOIR ENGINEERING (3-6) Applications of the principles of fluid behavior in porous media to the analysis of complex reservoir behavior; log interpretation. Prerequisite: P.N.G. 510.
- 515. SECONDARY RECOVERY (3) Methods of predicting oil recovery by immiscible fluid injection.
- 517. CASE STUDIES OF SECONDARY RECOVERY (1-3) Interpretation and critical analysis of production and injection characteristics of typical water flood operations. Prerequisite: P.N.G. 515 or 485.
- 520. PHASE RELATIONS IN RESERVOIR ENGINEERING (3) Phase relations as applied to condensate and retrograde condensate reservoirs and to other problems in petroleum production.
- 525. SPECIAL TOPICS IN PETROLEUM ENGINEERING (2-6)
- 530. NATURAL GAS ENGINEERING (1-3) Flow in producing or storage reservoirs; gas well testing; transmission systems; storage cycles; current developments. Prerequisite: P.N.G. 481.
- †535. SEMINAR (1-3)

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in petroleum and natural gas studies are listed under Mineral Sciences in Part II of this bulletin.*

## PHILOSOPHY

JOHN M. ANDERSON, *Head of the Department*  
119 Sparks Building

*Degrees Conferred:* Ph.D., D.Ed., M.A., M.Ed.

*Graduate Faculty:* Professors Anderson, Bugbee, Finch, Freund, Johnstone, and Mourant; Associate Professor Pape; Assistant Professors Gotshalk, Rosen, and Tsugawa.

A student may concentrate on history of philosophy, logic and scientific methods, or value theory. Undergraduate preparation should include a major in philosophy, but a strong minor may also be acceptable.

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\*Credits to be arranged, 3 per term.

†Credits to be arranged, 1 per term.



## PHILOSOPHY

### PHILOSOPHY (PHIL)

- 406. MEDIEVAL PHILOSOPHY (3)
- 410. STUDIES IN GREEK PHILOSOPHY (3-6)
- 411. STUDIES IN MODERN PHILOSOPHY (3-6)
- 413. PHILOSOPHY OF LITERATURE (3)
- 414. AESTHETIC THEORY (3)
- 417. NINETEENTH CENTURY PHILOSOPHY (3)
- 418. RECENT AND CONTEMPORARY PHILOSOPHY (3)
- 419. PHILOSOPHICAL BACKGROUNDS OF AMERICAN THOUGHT (3)
- 426. METAPHYSICS (3)
- 427. ADVANCED ETHICS (3)
- 428. (Math. 428) LOGICAL THEORY (3)
- 429. SEMANTICS: PHILOSOPHY OF LANGUAGE AND SYMBOLISM (3)
- 430. PHILOSOPHICAL PROBLEMS (3-6)
  
- 500. ETHICS: HISTORICAL AND SYSTEMATIC (2-6) Critical study of some phase of ethical theory, or of some period of the history of ethics.
- 504. SOCIAL AND POLITICAL PHILOSOPHY (3) Critical study of basic problems in their historical and functional setting.
- 505. IDEALS OF WESTERN CIVILIZATION (3) Analysis of contemporary ideals in terms of their Graeco-Judean bases.
- 506. SEMINAR IN ANCIENT PHILOSOPHY (3-6) Study of one or more important men or movements in ancient philosophy.
- 507. SEMINAR IN MEDIEVAL PHILOSOPHY (3-6) Study of one or more important men or movements in medieval philosophy.
- 508. SEMINAR IN MODERN PHILOSOPHY (3-6) Men and movements in philosophy from the Renaissance through the 19th century.
- 509. SEMINAR IN CONTEMPORARY PHILOSOPHY (3-6) Men and movements in 20th century philosophy.
- 510. CLASSICS OF SCIENTIFIC METHOD (3-6) Actual reasoning and procedures of historical masters of scientific methods.
- 511. PRINCIPLES OF EXPERIMENTAL INFERENCE (3-6) Science as controlled inquiry; types of scientific procedures in formal, physical, and sociocultural science.
- 512. ADVANCED TOPICS IN PHILOSOPHY OF SCIENCE (3-6) Crucial problems in the theory of science and scientific method.
- 514. SEMINAR IN 19TH CENTURY PHILOSOPHY (3) Study of a philosopher or philosophical movement of the 19th century.
- 515. PHILOSOPHICAL METHOD (3) Methods proposed by classical and contemporary thinkers for reaching philosophical conclusions: deductive, inductive, dialectical, pragmatic, intuitive.
- 516. SEMINAR IN AESTHETICS (3) Problems and theories in the nature of art.
- 530. PHILOSOPHY RESEARCH SEMINAR (3-6) Study of selected philosophical problems with an emphasis on techniques of philosophical research.
- 550-551. (Math. 550-551) FOUNDATIONS OF MATHEMATICAL LOGIC (3 each) The nature of logical basis of mathematics; critical examination and development of the basic parts of logical calculus. Prerequisite: Math. 480 or Phil. (Math.) 428.

554. (Math. 554) METAMATHEMATICS (3) Prooftheoretic and modeltheoretic study of systems: Gödel's theorem, relative and absolute consistency proofs, decidability, properties of relational structures, mathematical applications. Prerequisite: Phil. (Math.) 428.
556. (Math. 556) RECURSION THEORY (3) Recursive functions; recursive and recursively enumerable sets; equivalent formulations of computability; Church's thesis; related topics from current literature. Prerequisite: Phil. (Math.) 428.

## PHYSICAL EDUCATION

JOHN D. LAWTHER

*Associate Dean of the College of Physical Education and Athletics*  
246 Recreation Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Bedenk, Conger, Coombs, Davis, Gross, Harnett, Lawther, Speidel, and Thiel; Associate Professors Lucey and Magnusson.

Areas of specialization include: (1) history, philosophy, and principles; (2) applied science (physiology of exercise, kinesiology, body mechanics); (3) organization and administration; (4) objectives, programs, methods, and evaluation; (5) adaptives and correctives; (6) health; and (7) athletics, intramural and interschool. The master's candidate is expected to acquire a basic minimum of knowledge in each of these areas with little specialization except for his thesis or problem. The doctoral candidate is expected to focus on one area during his final year of graduate work.

The requirements for admission to the M.Ed. program are 24 credits in professional health and physical education and 24 in education and psychology, including general psychology, educational psychology, principles and methods of teaching, education electives, and practice teaching.

The requirements for admission to the M.S. program are 36 credits in professional health and physical education and 18 in education and psychology. An excellent background in the biological and physical sciences may satisfy up to half of the requirement in professional health and physical education.

### PHYSICAL EDUCATION (PH ED)

441. ADVANCED COACHING OF ATHLETICS FOR MEN (1 per unit)
- |                             |                        |
|-----------------------------|------------------------|
| Unit A. Basketball (1)      | Unit G. Swimming (1)   |
| Unit B. Football (1)        | Unit H. Gymnastics (1) |
| Unit C. Track and Field (1) | Unit I. Boxing (1)     |
| Unit D. Baseball (1)        | Unit J. Lacrosse (1)   |
| Unit E. Wrestling (1)       | Unit K. Fencing (1)    |
| Unit F. Soccer (1)          |                        |
449. ADVANCED TEACHING OF SPORTS AND RHYTHMICS (1 per unit)
- |                                    |                                |
|------------------------------------|--------------------------------|
| Unit A. Soccer and Speedball (1)   | Unit H. Early American Country |
| Unit B. Basketball (1)             | Dancing and Social Danc-       |
| Unit C. Field Hockey (1)           | ing (1)                        |
| Unit D. Archery (1)                | Unit I. Tennis (1)             |
| Unit E. Swimming (1)               | Unit J. Badminton (1)          |
| Unit F. Rhythmics for Children (1) | Unit K. Golf (1)               |
| Unit G. Modern Dance and Accom-    |                                |
| paniment (1)                       |                                |
452. ANALYSIS OF PHYSICAL EDUCATION ACTIVITIES FOR THE ELEMENTARY SCHOOL (3)

## PHYSICAL EDUCATION

453. ANALYSIS OF PHYSICAL EDUCATION ACTIVITIES FOR THE HIGH SCHOOL (3)  
454. THE NATURAL PROGRAM OF PHYSICAL EDUCATION ACTIVITIES, APPLIED (3)  
455. SCIENTIFIC METHOD IN HEALTH AND PHYSICAL EDUCATION (3)  
460. METHODS AND PRINCIPLES OF ATHLETIC COACHING (3)  
480. ADVANCED ANATOMY AND PHYSIOLOGY, APPLIED (3)  
489. INTRAMURAL ATHLETICS (3)  
490. INTRODUCTION TO TESTS AND MEASUREMENTS IN HEALTH AND PHYSICAL EDUCATION (3)  
491. ORGANIZATION AND ADMINISTRATION OF HEALTH AND PHYSICAL EDUCATION IN SCHOOLS (3)  
  
500. PROBLEM IN PHYSICAL EDUCATION (3) Prerequisite: Ph.Ed. 455.  
522. ORGANIZATION AND ADMINISTRATION OF PHYSICAL EDUCATION IN COLLEGES AND UNIVERSITIES (3) Administration of physical education in college; credits, schedules, excuses, records, reports, budgets, classification, tests, staff, and facilities. Prerequisite: Ph.Ed. 491.  
523. ADMINISTRATION OF COLLEGE ATHLETICS (3) Eligibility, schedules, managerial systems, relationships of athletics to the physical education program and to education in general. Prerequisite: Ph.Ed. 491.  
526. ATHLETIC PROBLEMS IN SCHOOLS (3) Practical problems which result from administration of athletics in schools. Reports on some aspects of athletics required. Prerequisite: Ph.Ed. 460.  
528. PROFESSIONAL EDUCATION OF TEACHERS OF HEALTH AND PHYSICAL EDUCATION (3) Health and physical education surveys, publicity, sociability and personality tests, legislation, state certification, standards for facilities and equipment, in-service follow-up, and teacher-community problems. Prerequisite: Ph.Ed. 491.  
529. SUPERVISION OF PHYSICAL EDUCATION IN SCHOOLS (3) Methods and policies of the school supervisor of physical education; conferences, planning and presenting the program, evaluating results, improving teachers-in-service, supervision of the classroom teacher. Prerequisite: Ph.Ed. 491.  
530. RESEARCH TECHNIQUES IN HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (3) Prerequisite: Ph.Ed. 490.  
531. RESEARCH IN HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (3) Prerequisite: Ph.Ed. 530.  
532. TESTS AND MEASUREMENTS IN PHYSICAL EDUCATION (3) Critical study of tests and measurements available in physical education; methods of constructing and evaluating new tests and measurements. Prerequisite: Ph.Ed. 490.  
534. STUDIES IN CURRICULUM CONSTRUCTION IN PHYSICAL EDUCATION (3) Principles and methods of curriculum building in physical education; different psychological and educational points of view, organizing a course of study committee, making units of instruction. Prerequisite: Ph.Ed. 454.  
535. MODERN FOREIGN SYSTEMS OF PHYSICAL EDUCATION (3) Comparative analysis of national and local programs and systems of physical education in foreign countries. Prerequisites: Ph.Ed. 534, 595.  
536. SCIENTIFIC METHODS IN ATHLETIC COACHING (3) Unusual techniques in athletic coaching which are not commonly recognized and used; advanced skills and strategy in coaching major sports. Prerequisite: Ph.Ed. 460.  
550. SEMINAR IN HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (1-6)



555. RELATIONSHIPS OF PHYSICAL EDUCATION TO THE EXACT SCIENCES (3)
560. ADMINISTRATIVE PROBLEMS OF PHYSICAL EDUCATION IN SCHOOLS (3) Solutions to problems emerging from the administration of physical education in schools, fitting physical education into the school's schedule, awards and budgets. Prerequisite: Ph.Ed. 491.
581. PROBLEMS IN BODY MECHANICS (3) Certain aspects of human motion and body segmental alignment; analysis of human gait, and the dynamic adaptation of the spine, thorax, and pelvis to external physical forces. Prerequisites: Hl.Ed. 244, Ph.Ed. 399.
595. PHILOSOPHY OF HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (3) Prerequisite: Ph.Ed. 491 or Rc.Ed. 465.

## PHYSICAL SCIENCE

HENRY W. KNERR

*Chairman of the Committee on Physical Science*  
101 Willard Building

*Degrees Conferred:* D.Ed., M.Ed.

The M.Ed. program, which is designed to meet the needs of secondary school science teachers, consists of at least 24 credits chosen from chemistry, earth sciences, mathematics, and physics and a minor of at least 6 credits in educational foundations. A candidate is expected to complete at least one course in each of the four sciences and at least 12 credits in chemistry, earth sciences, or physics.

As a minimum requirement for admission a student is expected to have had 10 credits in chemistry, 8 credits in physics, mathematics through trigonometry, and 18 credits in education and related psychology.

## PHYSICS

JOHN A. SAUER, *Head of the Department*  
101 Osmond Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Fitzgerald, Gibbons, Knerr, Müller, Pepinsky, Pollard, Rank, Roy, Sauer, Schilling, Stoner, Vand, and Webb; Associate Professors Bauer, Burnett, Donahue, Drenck, McCubbin, Myers, Pratt, Rix, Strother, Weber, Wiggins, Winter, and Work; Assistant Professors Cutler, Goldburg, Kazes, McCammon, Signell, and Thwaites.

Graduate instruction and research opportunities are available in visible and infrared spectroscopy, crystal structure, solid state, field emission, acoustics, high-pressure physics, biophysics, plasma physics and shock waves, low-temperature physics, nuclear physics, physics of high polymers, and various phases of theoretical physics.

A bachelor's degree in physics or an allied field is required for admission. Students who lack some of the usual upper-class undergraduate courses in physics may be requested to take additional course work without degree credit.

## PHYSICS

### PHYSICS (PHYS)

- 400. INTERMEDIATE ELECTRICITY AND MAGNETISM (4)
- 402. ELECTRONICS (4)
- 404. ELECTRONIC MEASUREMENTS (2-4)
- 406. NUCLEAR PHYSICS (3)
- 411. THEORETICAL MECHANICS (3)
- 412. THEORY OF THE SOLID STATE (3)
- 417. THE TEACHING OF PHYSICS (3)
- 420. INTERMEDIATE HEAT (3)
- 433. MECHANICS AND FLUID PHYSICS FOR TEACHERS (3)
- 435. ELECTRICITY AND MAGNETISM FOR TEACHERS (3)
- 436. OPTICS FOR TEACHERS (3)
- 437. HEAT, WAVE MOTION, AND SOUND FOR TEACHERS (3)
- 439. ELEMENTARY SURVEY OF MODERN PHYSICS FOR TEACHERS (3)
- 441. DEMONSTRATION EXPERIMENTS FOR TEACHERS (3)
- 443. INTERMEDIATE ACOUSTICS (3)
- 444. MEASUREMENTS IN ACOUSTICS (2)
- 454. ATOMIC AND NUCLEAR PHYSICS (3)
- 456. ATOMIC AND NUCLEAR PHYSICS (3)
- 457. EXPERIMENTAL ATOMIC PHYSICS (2)
- 458. INTERMEDIATE OPTICS (4)
- 461. THEORETICAL MECHANICS (3)
- 467. INTERMEDIATE ELECTRICITY AND MAGNETISM (3)
- 470. SPECIAL TOPICS (1-9)
- 473-474. BIOPHYSICS (3 each)
- 477. X-RAY ANALYSIS OF SOLIDS AND LIQUIDS (3)
  
- 507. THERMODYNAMICS AND KINETIC THEORY (3) Classical and modern thermodynamics; introduction to statistical mechanics.
  
- 509. PHYSICS SEMINAR (1-3 per term) Topics from current research.
- 512-513. SOLID STATE PHYSICS (3 each) Analytical treatment of physical properties of solids: crystal structure, X-ray diffraction, lattice vibrations, paramagnetism, ferromagnetism, ferroelectricity; electron theory of metals, semiconductors. Prerequisite: Phys. 530.
  
- 517. STATISTICAL MECHANICS (3) Classical and quantum statistics, theory of ensembles, degenerate gases, applications to low temperature effects and co-operative phenomena. Prerequisites: Phys. 507, 561.
  
- 521. CRYSTAL STRUCTURE (3) Crystal symmetry, X-ray scattering, theory and techniques of crystal structure determination.
  
- 522. ADVANCED CRYSTAL ANALYSIS (3) Phase-determining methods in crystal analysis.
  
- 530. THEORETICAL MECHANICS (3) Newtonian mechanics; Lagrange's equations, Hamilton's principle; Hamilton's equations; coupled systems; waves in strings, central field problem; rigid bodies; elasticity; hydrodynamics.
  
- 532. ADVANCED THEORETICAL MECHANICS (3) Least action principle; canonical transformation; Lagrange and Poisson brackets; Hamilton-Jacobi equations; classical theory of fields. Prerequisite: Phys. 530.
  
- 533. THEORETICAL ACOUSTICS (3) Vibrating systems; transmission of disturbances through elastic and visco-elastic media. Prerequisite: Phys. 530.

- 553-554. NUCLEAR PHYSICS (3 each) Discussion and theoretical interpretation of basic experiments involving atomic nuclei and nuclear radiations. Prerequisite: Phys. 562.
557. ELECTRICITY AND MAGNETISM (3) Electro- and magnetostatics, Maxwell's equations, boundary value problems, electric and magnetic properties of material media.
558. ADVANCED ELECTRICITY AND MAGNETISM (3) Energy and momentum in the field, radiation theory, classical relativistic electron theory. Prerequisite: Phys. 557.
560. RESEARCH PROBLEMS (1-18) Introduction to research through individual assignments.
- 561-562. QUANTUM MECHANICS (3 each) The basic theory of wave and matrix mechanics, approximation methods, applications. Prerequisite: Phys. 530.
- 563-564. ADVANCED QUANTUM MECHANICS (3 each) Relativistic wave equations, quantum field theory, other advanced quantum theoretical topics. Prerequisite: Phys. 562.
565. REACTOR ANALYSIS (4) Physical principles and mathematical methods of reactor analysis. Prerequisite: Phys. 406.
566. REACTOR ANALYSIS (3) Continuation of Phys. 565. Prerequisite: Phys. 565.
571. ATOMIC PHYSICS (3) Experimental basis of modern physics; atomic spectra and structure, nuclear phenomena.
572. SELECTED TOPICS IN SPECTROSCOPY (3) Atomic and molecular spectra, experimental methods and theoretical analyses.
575. SPECIAL TOPICS (1-3 per term) Theoretical studies in any field of modern physics with or without associated experimental work. Prerequisite: Phys. 456.

## PLANT PATHOLOGY

ALVIN R. GROVE

*Acting Head of the Department of Botany and Plant Pathology*  
206 Buckhout Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Fergus, Kneebone, Lewis, Mills, and Wernham; Associate Professors Bloom, Boyle, Couch, Graham, Schein, and Tammen; Assistant Professor Stambaugh.

A student may specialize in the study of plant diseases caused by fungi, bacteria, or viruses, and/or in their control, especially by plant breeding or by chemical means.

For admission a student must present at least 27 credits in botany, plant pathology, and biological science, of which not more than 6 may be in biological science. As many as 6 credits may be made up as undergraduate deficiencies after the candidate has been admitted to the Graduate School.

See also courses listed under botany, especially Bot. (P.Path.) 419; Bot. 421, 501; Bot. (P.Path.) 522, 523; and Bot. 526.



## PLANT PATHOLOGY

### PLANT PATHOLOGY (P PATH)

404. DISEASES OF FIELD AND FORAGE CROPS (3) *Messrs. Schein and Couch*  
408. PLANT PATHOLOGICAL TECHNIQUES (3) *Mr. Bloom*  
412. ADVANCED FOREST PATHOLOGY (3) *Mr. Fergus*  
419. (Bot. 419) MYCOLOGY (3) *Mr. Fergus*  
425. DISEASES OF ORNAMENTAL AND FLORICULTURAL PLANTS (3) *Mr. Tammen*  
428. DISEASES OF FRUIT AND VEGETABLE CROPS (3) *Messrs. Bloom and Boyle*
501. CLINICAL PLANT PATHOLOGY (3) Advanced course in diagnostic techniques to acquaint the students with specialized procedures for field and laboratory identification of plant diseases. Prerequisites: P.Path. 10, 408, P.Path. (Bot.) 419. Summer term only. *Mr. Couch*
509. PRINCIPLES OF PLANT INFECTION (3) Physiological processes of plant pathogenic bacteria and fungi occurring during incubation, ingress, and infection. Prerequisites: P.Path. 10 or 11, P.Path. (Bot.) 419. Winter term, odd years. *Mr. Schein*
515. DISEASE RESISTANCE IN PLANTS (2-4) Stability of resistance, selection of resistant material, economics of control, special problems. Prerequisites: Bot. (Zool.) 22 or 33, P.Path. 10. Fall term, odd years. *Messrs. Wernham and Mills*
518. (Bot. 518) SPECIAL PROBLEMS (1-12) The prosecution of an assigned problem under the guidance of a staff member. Throughout the year as arranged. By appointment.
519. VIRUS DISEASES OF PLANTS (3) Nature, symptomatology, transmission, and control of virus diseases of plants. Fall term, even years. *Mr. Boyle*
520. PLANT PATHOGENIC BACTERIA (3) Bacteria causing plant diseases; methods of identification, inoculation, and control. Spring term, odd years. *Mr. Kneebone*
522. (Bot. 522) MYXOMYCETES, PHYCOMYCETES, AND ASCOMYCETES (4) Morphology, taxonomy, phylogeny, and life histories; identification and field work. Prerequisite: P.Path. (Bot.) 419. Winter term, even years. *Mr. Fergus*
523. (Bot. 523) BASIDIOMYCETES AND FUNGI IMPERFECTI (4) Morphology, taxonomy, phylogeny, and life histories. Prerequisite: P.Path. (Bot.) 419. Spring term, even years. *Mr. Fergus*
530. PLANT DISEASE CONTROL (3) Methods, and laboratory and field testing of materials used in plant disease control. Spring term, even years.
531. PLANT PATHOLOGY SEMINAR (1 per term) Selected topics of current research, history, and contemporary trends in plant pathology.

## POLITICAL SCIENCE

ELTON ATWATER, *Head of the Department*  
129 Sparks Building

*Degrees Conferred:* Ph.D., M.A., M.P.A.

*Graduate Faculty:* Professors Aspaturian, Atwater, Brewster, Ferguson, McGeary, Riemer, and Silva; Associate Professor Monat; Assistant Professors Albinski and Wingfield.

Students may specialize in American government, public administration, political theory, international relations, or comparative government.

Applicants for admission to the M.A. and Ph.D. programs will be expected to have at least 12 credits in political science or its equivalent. In exceptional cases students may be permitted to make up deficiencies after beginning their graduate programs.

Candidates for the M.P.A. must present for admission, or make up without graduate credit, at least 6 credits in political science and at least 3 credits in each of the following fields: economics, public finance, accounting or statistics, and psychology.

All candidates will take a core program and specialize in one of the following options: General Public Administration, Public Planning Administration, International Administration, or City Management.

POLITICAL SCIENCE (PL SC)

- |                                                                          |                                                 |
|--------------------------------------------------------------------------|-------------------------------------------------|
| 401. POLITICAL BEHAVIOR (3)                                              | <i>Mr. Noel</i>                                 |
| 411. AMERICAN POLITICAL THEORY (3)                                       | <i>Mr. Riemer</i>                               |
| 413. GOVERNMENT AND POLITICS OF THE SOVIET UNION (3)                     | <i>Mr. Atwater</i>                              |
| 414. FOREIGN POLICY OF THE SOVIET UNION (3)                              | <i>Mr. Aspaturian</i>                           |
| 415. INTERNATIONAL ORGANIZATION (3-6)                                    | <i>Messrs. Aspaturian and Atwater</i>           |
| 416. INTERNATIONAL LAW (3)                                               | <i>Mr. Aspaturian</i>                           |
| 417. AMERICAN LOCAL GOVERNMENT AND ADMINISTRATION (3)                    | <i>Mr. Wingfield</i>                            |
| 419. PUBLIC ADMINISTRATION (3)                                           | <i>Mr. McGeary</i>                              |
| 421. MODERN POLITICAL THEORY (3)                                         | <i>Mr. Riemer</i>                               |
| 426. POLITICAL PARTIES (3)                                               | <i>Miss Silva</i>                               |
| 427. POLITICAL OPINION AND PROPAGANDA (3)                                | <i>Miss Silva</i>                               |
| 431. ANCIENT AND MEDIEVAL POLITICAL THEORIES (3)                         | <i>Messrs. Hobbs and Riemer</i>                 |
| 432. CURRENT POLITICAL TRENDS AND PROBLEMS IN THE UNITED STATES (3-9)    |                                                 |
| 433. THE LAW OF LABOR-MANAGEMENT RELATIONS (3)                           | <i>Mr. Brewster</i>                             |
| 442. AMERICAN FOREIGN POLICY (3)                                         | <i>Mr. Atwater</i>                              |
| 444. GOVERNMENT REGULATION (3)                                           | <i>Mr. Ferguson</i>                             |
| 445. ADMINISTRATIVE LAW (3)                                              | <i>Mr. Brewster</i>                             |
| 446. JUDICIAL SYSTEMS (3)                                                |                                                 |
| 447. CONSTITUTIONAL LAW: THE FEDERAL SYSTEM (3)                          | <i>Miss Silva</i>                               |
| 448. CONSTITUTIONAL LAW: GOVERNMENT AND THE INDIVIDUAL (3)               | <i>Mr. Brewster</i>                             |
| 450. GOVERNMENTS AND FOREIGN POLICIES OF THE COMMONWEALTH OF NATIONS (3) | <i>Mr. Albinski</i>                             |
| 451. COMPARATIVE POLITICAL SYSTEMS (3)                                   | <i>Mr. Albinski</i>                             |
| 456. GOVERNMENTS AND FOREIGN POLICIES OF LATIN AMERICA (3)               |                                                 |
| 458. GOVERNMENTS AND FOREIGN POLICIES OF THE FAR EAST (3-6)              |                                                 |
| 499. FOREIGN STUDY IN GOVERNMENT (2-6)                                   |                                                 |
| 500. SEMINAR IN POLITICAL SCIENCE (3-12)                                 | Subject to be announced.<br><i>Mr. Brewster</i> |
| 505. SEMINAR IN ADVANCED AMERICAN GOVERNMENT (3-12)                      |                                                 |
| 509. RESEARCH TECHNIQUES IN POLITICAL SCIENCE (3)                        |                                                 |
| 512. COMPARATIVE GOVERNMENT (3-12)                                       | <i>Mr. Albinski</i>                             |
| 515. INTERNATIONAL RELATIONS (3-6)                                       | <i>Mr. Atwater</i>                              |
| 517. INTERNATIONAL ORGANIZATION (3-6)                                    | <i>Mr. Aspaturian</i>                           |
| 519. PUBLIC ADMINISTRATION (3-6)                                         | <i>Mr. McGeary</i>                              |
| 521. POLITICAL THEORY (3-6)                                              | <i>Mr. Riemer</i>                               |

## POLITICAL SCIENCE

535. GOVERNMENT REGULATION (3-6)
570. CURRENT TRENDS AND PROBLEMS IN ADMINISTRATION (3-6) *Mr. Ferguson*
571. THEORY OF PUBLIC MANAGEMENT (3-6) The role of the executive in modern government; the objectives of public administration; theories of administrative organization and practice. *Mr. Monat*
572. INTERNATIONAL ADMINISTRATION (3-6) The execution of foreign policies through national and international public and private organizations.
575. PUBLIC PERSONNEL ADMINISTRATION (3) Government personnel systems; current trends and problems; essentials of recruitment, classification and pay, ratings, supervision, training, and discipline.
576. PUBLIC FISCAL ADMINISTRATION (3) The role of the executive in fiscal planning; budget preparation; expenditure control; tax assessment and collection; investment of public funds. *Mr. Monat*
577. PUBLIC ORGANIZATION AND METHODS (3) Principles of government organization; management surveys; work measurement; methods of achieving efficiency and economy. *Mr. Wingfield*
578. PUBLIC PLANNING AND ZONING (3) Public planning agencies and their functions; essentials of effective planning and zoning; current trends and problems. *Mr. Wingfield*
580. INTERNSHIP IN PUBLIC ADMINISTRATION (6)

## POULTRY HUSBANDRY

ARTHUR J. G. MAW, *Head of the Department*  
103 Weaver Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Bressler, Hale, Margolf, Maw, and Murphy; Associate Professors Buss, Mueller, and Schein.

Students may specialize in poultry nutrition, poultry management, poultry products, poultry breeding, or animal behavior. In each area the program consists of a joint major between the Department of Poultry Husbandry and one or more basic science departments. Admission requirements vary according to the area of specialization. Students with undergraduate majors in the basic sciences may qualify.

Excellent facilities are available for research in production, processing, and preservation of market eggs and dressed poultry, and in chick and poult nutrition. A specially designed and equipped Solar Laying House also provides facilities for investigation of production and behavioral problems encountered in large, concentrated populations of layers.

### POULTRY HUSBANDRY (P H)

401. (Psy. 401, Zool. 401) ANIMAL BEHAVIOR (3) *Mr. Hale*
402. SPECIAL TOPICS (3-12)
502. ADVANCED POULTRY NUTRITION (2-4) *Mr. Murphy*



## POULTRY HUSBANDRY

503. ADVANCED POULTRY FARM MANAGEMENT (2-4) *Mr. Bressler*
504. ADVANCED MARKET POULTRY AND EGGS (2-4) Prerequisites: P.H. 1, 7; Ag.Ec. 33 or 2 additional credits in poultry husbandry. *Messrs. Margolf and Mueller*
505. RESEARCH IN POULTRY HUSBANDRY (1-10 per term) Prerequisite: 9 credits in poultry husbandry.
506. SEMINAR IN POULTRY HUSBANDRY (1-6)
582. (Psy. 582, Zool. 582) RESEARCH IN ANIMAL BEHAVIOR (2-6 per term) Research in special areas of animal behavior involving field or laboratory work. Prerequisite: P.H. (Psy., Zool.) 401; or Psy. 403. *Messrs. Hale and Schein*

## PSYCHOLOGY

ARTHUR H. BRAYFIELD, *Head of the Department*  
112 Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S.

*Graduate Faculty:* Professors Adams, Bernreuter, Brayfield, Carpenter, Corso, Hale, Guest, Guthrie, Hall, Harris, Lepley, Smith, W. U. Snyder, and VanOrmer; Associate Professors Gorlow, Jackson, Thevaos, Warren, and Whaley; Assistant Professors Hoffman, Piers, Prokasy, and Helen Snyder.

Graduate instruction and research opportunities are available in the following areas of psychology: general experimental, physiological and comparative, measurement and statistics, social and personality, developmental and educational, clinical and counseling, school, industrial and business, engineering, and human factors.

Special research and training facilities include the Penn State Anechoic Chamber, the University Computer Center, the Laboratory for Physiological and Comparative Psychology, the Psychology Clinic, the Division of Counseling, and the Special Education unit.

Requirements for admission include a broad undergraduate preparation, a junior-senior scholastic average of B, a minimum of 12 credits in psychology, and a satisfactory graduate student rating on a scholastic aptitude examination. Applicants with a master's degree will have their admission evaluated with emphasis on the quality of their graduate program.

### PSYCHOLOGY (PSY)

400. HONORS COURSE IN PSYCHOLOGY (2-6)
401. (P.H. 401, Zool. 401) ANIMAL BEHAVIOR (3) *Mr. Hale*
403. INTRODUCTORY PHYSIOLOGICAL PSYCHOLOGY (3) *Mr. Warren*
411. PSYCHOLOGY OF THE PRESCHOOL CHILD (3)
412. ABNORMAL PSYCHOLOGY (3) *Mr. Guthrie*
414. INTERMEDIATE EDUCATIONAL PSYCHOLOGY (2-3) *Miss Snyder*
415. INTERMEDIATE STATISTICS IN PSYCHOLOGY AND EDUCATION (3) *Mr. Prokasy*
417. SOCIAL PSYCHOLOGY (2-3) *Mr. Singer*
418. MEASUREMENT OF PERSONALITY (3)
419. GUIDANCE AND EDUCATION IN SEXUAL AND MARITAL ADJUSTMENT (3) *Mr. Adams*
420. APPLIED SOCIAL PSYCHOLOGY (3)
422. PSYCHOLOGICAL METHODS OF MEASURING THE REACTIONS OF THE PUBLIC (3) *Mr. Guest*

## PSYCHOLOGY

423. TEST CONSTRUCTION AND STANDARDIZATION (2-3)
  425. PSYCHOLOGY OF THE ELEMENTARY SCHOOL CHILD (2-3) *Mr. Whaley*
  426. ADOLESCENCE (2-3) *Mr. Harris*
  427. PSYCHOLOGICAL PRINCIPLES IN ADVERTISING (3) *Mr. Guest*
  428. OPINION RESEARCH LABORATORY (3) *Mr. Guest*
  429. PSYCHOLOGY OF COMMUNICATION (3)
  431. INDUSTRIAL PSYCHOLOGY (3) *Mr. Smith*
  432. INTRODUCTORY ENGINEERING PSYCHOLOGY (3) *Mr. Corso*
  433. PSYCHOLOGY OF OCCUPATIONAL BEHAVIOR (2) *Mr. Brayfield*
  436. MENTAL HYGIENE IN SCHOOLS (3)
  437. PSYCHOLOGY OF ADJUSTMENT (3) *Mr. Gorlow*
  438. THEORY OF PERSONALITY (3) *Mr. Jackson*
  440. PSYCHOLOGY PROJECTS (1-6)
  441. INDUSTRIAL MOTIVATION AND MORALE (3)
  445. (C.D.F.R. 445) DEVELOPMENT THROUGHOUT ADULTHOOD (3)
  450. MEASUREMENT OF ABILITIES (3)
  474. PSYCHOLOGY OF EXCEPTIONAL CHILDREN (3) *Miss Piers*
  482. INTRODUCTION TO CLINICAL PSYCHOLOGY (3)
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500. SEMINAR INTRODUCTION TO GRADUATE STUDY (0) For all new graduate students in psychology.
  501. ADVANCED PSYCHOLOGY (3) Comprehensive study of general psychology. Prerequisite: 9 credits in psychology. *Mr. Lepley*
  502. ADVANCED EDUCATIONAL PSYCHOLOGY (2-4) Psychological theories and principles underlying educational theories and practices. Prerequisites: Psy. 14 or 414; practice teaching or teaching experience.
  503. PHYSIOLOGICAL PSYCHOLOGY (2-6) Correlations between structure and function of nervous system and human consciousness; laws and theories in fields of sensation, attention, association, affection, and thought. Prerequisite: 9 credits in psychology. *Mr. Warren*
  504. COMPARATIVE PSYCHOLOGY (2-4) Behavior from standpoint of phylogenetic growth and development; biological implications; comparison of different types of animals, including man. Prerequisite: 9 credits in psychology. *Mr. Warren*
  505. RESEARCH PROBLEMS IN PSYCHOLOGY (1-15) Prerequisite: 12 credits in psychology.
  509. ADVANCED THEORY OF LEARNING AND HABIT FORMATION (2-3) Critical evaluation of major theories of learning: Hull, Guthrie, Tolman, Lewin; application of learning theory to major problems in psychology. Prerequisite: Psy. 4 or 414.
  510. HISTORY OF PSYCHOLOGY (3) Theoretical systems, experiments, and personalities in development of modern psychology until about 1920. Prerequisite: 9 credits in psychology. *Mr. Corso*
  511. CONTEMPORARY AMERICAN PSYCHOLOGY (2-3) Current systems or schools of psychology with comparative study and critical analysis; points of view as presented by recognized leaders. Prerequisite: 9 credits in psychology. *Mr. Hall*
  513. EDUCATIONAL PSYCHOLOGY: DIFFERENTIAL (3) Causes of differences in achievement and personality; psychological implications of methods used by schools in adjusting to individual differences. Prerequisites: Psy. 14 or 414; 6 credits at 400 level in psychology.



514. EDUCATIONAL PSYCHOLOGY: LEARNING (2) Experimentally determined facts about the learning process; synthesis of main theories of learning; application of principles related to: motivation, practice, retention, transfer, meaning, and problem solving. Prerequisites: Psy. 14 or 414; 6 credits at 400 level in psychology.
515. ADVANCED STATISTICS IN PSYCHOLOGY AND EDUCATION (3) Correlation theory and methods, discriminant function, and factor analysis; applications to mental test theory. Prerequisite: Psy. 415 or Ed.Ser. 590.
516. THEORIES OF DECISION-MAKING (3) Theoretical models and experimental evidence concerning choice behavior, strategies, and values, under riskless conditions and under uncertainty and risk.
517. PSYCHOLOGY OF ATTITUDES AND OPINIONS (3) Acquisition and control of attitudes and opinions, including beliefs, convictions, biases, prejudices, and ideologies as determinants of action. Prerequisite: 18 credits in psychology, including Psy. 417, 422, 437.
518. PROJECTS IN EXPERIMENTAL PSYCHOLOGY (2-4) Individual experimental projects; seminars on experimental design and instrumentation.
522. SURVEY RESEARCH TECHNIQUES (3) Sample and questionnaire designs for investigation of consumer reactions and social issues, and appropriate analytic procedures. Prerequisite: 3 credits in statistics. *Mr. Guest*
527. STATISTICAL INFERENCE AND EXPERIMENTAL DESIGN (3) Probability theory, sampling distributions, analysis of variance and covariance, analysis of trend, non-parametric statistics, experimental design. Prerequisite: Psy. 415 or Ed.Ser. 590.
528. OPINION RESEARCH ADMINISTRATION (3-6) Practicum in planning, development of techniques, and administration of the sample survey. Prerequisites: Psy. 15, 21, 422. *Mr. Guest*
529. (C.D.F.R. 529) SEMINAR IN CHILD DEVELOPMENT (1-6) Readings and reports on recent findings in child development. Prerequisite: 6 credits in child development or 6 in educational or child psychology, plus 3 in statistics.
534. ADVANCED ENGINEERING PSYCHOLOGY (3) Experimental studies of psychological factors affecting design and operation of machines. Prerequisites: Psy. 3 and 4, or Psy. 432 or 501. *Mr. Corso*
535. HUMAN DEVELOPMENT (2-3) Psychological phases of human development throughout the life span; implications for school, community, and home. Prerequisite: 9 credits in psychology. *Mr. VanOrmer*
536. RESEARCH METHODS AND PROBLEMS IN EDUCATIONAL AND DEVELOPMENTAL PSYCHOLOGY (1-6) Prerequisites: Psy. 414 or 514; Ed.Ser. 490 or Psy. 415. *Mr. Harris*
537. SEMINAR IN INDUSTRIAL PSYCHOLOGY (3) Prerequisite: Psy. 431. *Mr. Smith*
538. PSYCHOLOGY OF PERSONNEL DEVELOPMENT (3) Industrial training in relation to psychological learning theory and experimental findings. Prerequisite: Psy. 431 or 414. *Mr. Smith*
539. MOTIVATION AND EMOTION (3) Systematic status of instinct, drive, motive, will, purpose; methodology and results of physiological, experimental, and clinical investigation of basic drives. Prerequisite: Psy. 503. *Mr. Hall*
540. SEMINAR IN CLINICAL PROBLEMS (1-6) Contemporary psychological theory, research, and methodology in relation to clinical psychology. Prerequisites: Psy. 542, 560.



## PSYCHOLOGY

541. PERSONALITY THEORY (3-4) Contemporary theories of personality and relevant research with emphasis upon normal processes. Prerequisite: Psy. 438.
542. PSYCHOPATHOLOGY (3-4) Theories of pathological behavior with reference to clinical and experimental data. Prerequisites: Psy. 412, 541.
543. SURVEY OF COUNSELING AND PSYCHOTHERAPY (3) Critical analysis of important systems of counseling and psychotherapy; history, rationale, and method. Prerequisite: Psy. 541.
551. THEORY AND PRACTICUM IN CLINICAL APPRAISAL OF ABILITIES AND INTELLIGENCE I (3-4) Theories of intellectual behavior; introduction to clinical testing with emphasis on individual intelligence tests. Prerequisites: Psy. 450, 482; or 15 credits in psychology. *Miss Piers*
552. THEORY AND PRACTICUM IN CLINICAL APPRAISAL OF ABILITIES AND INTELLIGENCE II (3) Theory, development of tests, and research in intellectual assessment; practicum experience with institutionalized subjects. Prerequisite: Psy. 551. *Miss Piers*
553. ADVANCED THEORY OF CLINICAL ASSESSMENT (3) Problems in clinical assessment of cognitive functioning, such as assessment of brain injury, aphasic behaviors, etc. Prerequisites: Psy. 542, 552.
555. THEORY AND PRACTICUM IN CLINICAL ASSESSMENT OF PERSONALITY (3) Theoretical issues and research in clinical assessment with special reference to administration and interpretation of projective methods. Prerequisites: Psy. 542, 552. *Mr. Jackson*
556. THEORY AND PRACTICUM IN CLINICAL ASSESSMENT OF PATHOLOGICAL SYNDROMES (3) Current research and theoretical issues in the clinical assessment of pathological syndromes; includes practicum. Prerequisite: Psy. 555. *Mr. Guthrie*
557. ADVANCED PERSONALITY ASSESSMENT (3) Personality and measurement theories related to problems of prediction, diagnosis, and research. Prerequisite: Psy. 556.
560. PRACTICUM IN CLINICAL METHODS (3-6) Personality and vocational diagnostic evaluations and short-term counseling with adults and children. Prerequisites: Psy. 482, 541, 551.
561. CLINICAL PRACTICUM WITH CHILDREN (1-3) Diagnosis and counseling of child-parent problems of learning and adjustment; includes principles of school psychology. Prerequisite: Psy. 560. *Miss Piers*
564. THEORY AND PRACTICUM IN COUNSELING AND PSYCHOTHERAPY WITH ADULTS (3-6) Counseling with personal adjustment problems referred to the Psychology Clinic. Prerequisites: Psy. 543, 560. *Mr. Snyder*
567. THEORY AND PRACTICUM IN COUNSELING AND PSYCHOTHERAPY WITH CHILDREN (1-3) Practical experience in the Psychology Clinic in use of play therapy with young children; staff meetings; seminar on principles and techniques. Prerequisites: Psy. 543, 560, 564. *Miss Piers*
569. ADVANCED THEORY AND PRACTICUM IN COUNSELING AND PSYCHOTHERAPY (3-6) Practical experience in the Psychology Clinic in advanced nondirective therapy techniques; staff meetings; case conferences. Prerequisite: Psy. 564. *Mr. Snyder*

571. SOCIAL PSYCHOLOGY (3) Historical development of theory and methods; determinants and principles of complex social or interactional behavior; contemporary problems and research. Prerequisite: 3 credits in social psychology.
580. THEORY AND CONSTRUCTION OF ATTITUDE SCALES (3) Measurement of social, political, commercial, and industrial attitudes; questionnaire designs. Prerequisite: 3 credits in statistics.
582. (P.H. 582, Zool. 582) RESEARCH IN ANIMAL BEHAVIOR (2-6 per term) Research in special areas of animal behavior involving field or laboratory work. Prerequisite: Psy. (P.H., Zool.) 401; or Psy. 403. *Messrs. Hale, Schein, and Warren*
590. PROBLEMS IN CLINICAL RESEARCH (1-6) Prerequisite: Psy. 415.
591. SEMINAR ON TEACHING PSYCHOLOGY (1-3) Objectives and content of psychology; organization and presentation of material; teaching aids and techniques. *Mr. Brayfield*

## RECREATION EDUCATION

FRED M. COOMBS, *in Charge of Recreation Education*  
244 Recreation Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

Students may prepare for recreation administrative positions in public recreation systems, industries, hospitals, camps, or private agencies; or for leadership of special groups in a particular activity. The areas for specialization include: (1) history, philosophy, and principles; (2) administration and supervision; (3) planning areas and facilities; (4) program content and application; (5) surveys and appraisals; (6) principles of the group process; and (7) research.

For admission an undergraduate major in recreation education is desirable; but a major in sociology, music, physical education, fine or industrial arts, theatre arts, or other related fields may be accepted.

Students who lack some of the prerequisite courses may be admitted but are required to make up the deficiency without degree credit.

### RECREATION EDUCATION (RC ED)

430. CAMPING AND OUTDOOR EDUCATION (3)
434. (L.Arch. 434) RECREATION AREAS AND FACILITIES (3)
456. SOCIAL RECREATION (3)
461. COMMUNITY RECREATION (3)
465. ADMINISTRATION OF RECREATION (3)
530. CAMP ADMINISTRATION (3) Camp site development; staff selection, training, and supervision; development of objectives and program planning; values inherent in outdoor and camping education. Prerequisite: Rc.Ed. 430.
533. RECREATION STUDIES, SURVEYS, AND APPRAISALS (3) Types, purposes, and methods of conducting recreation studies and surveys; procedures in appraisal of community recreation. Prerequisite: Ph.Ed. 530.

## RECREATION EDUCATION

560. ADMINISTRATIVE PROBLEMS OF RECREATION (3) Administrative problems in park and recreation departments; departmental organization, finance, personnel, facilities, program, and public relations. Prerequisite: Rc.Ed. 465.

## ROMANCE LANGUAGES AND LITERATURES

FRANKLIN B. KRAUSS

*Head of the Department of Romance Languages*  
301 Sparks Building

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Professors Eyer, Hyslop, Krauss, and LeSage; Associate Professors Belasco, Bleznick, Brentin, Chapman, Moser, Sturcken, and Wadsworth; Assistant Professor Triolo.

The minimum requirement for admission to an advanced degree program will normally be 24 credits of post-intermediate work in language and literature. A student concentrating in either French or Spanish may, if he wishes, choose the second area as a minor.

### FRENCH (FR)

400. FRENCH LITERATURE OF THE RENAISSANCE (3)  
405. FRENCH LITERATURE IN THE ROMANTIC PERIOD (3)  
406. FRENCH LITERATURE IN THE REALISTIC PERIOD (3)  
411. FRENCH PROSE OF THE 20TH CENTURY (3)  
413. CONTEMPORARY FRENCH DRAMA (3)  
416. FRENCH POETRY AND DRAMA OF THE 20TH CENTURY (3)  
421. THE TEACHING OF ROMANCE LANGUAGES (3)  
431. FRENCH LITERATURE OF THE CLASSICAL PERIOD (3)  
433. THE AGE OF ENLIGHTENMENT (3)  
471. PROBLEMS IN FRENCH LITERATURE (3-6)  
490. ADVANCED COMPOSITION AND CONVERSATION (3)
- \*1G. ELEMENTARY FRENCH FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.
501. FRENCH DRAMA OF THE CLASSICAL PERIOD (3) Origins and development of French classical comedy and tragedy, emphasizing the works of Corneille, Racine, and Molière.
549. SYMBOLISM (3) The anti-positivistic tradition in 19th century French literature dealing with the Symbolist School; its antecedents and its subsequent ramifications.
552. MEDIEVAL FRENCH LITERATURE (3) Familiarizes the student with Old and Middle French texts from the earliest monuments to Villon. Prerequisite: R.Ph. 551.
562. FRENCH THINKERS OF THE 18TH CENTURY (3)
570. VOLTAIRE AND ROUSSEAU (3)
571. SEMINAR IN FRENCH LITERATURE (3-12) Lectures on methods of research. Students will pursue common and individual investigations in fields selected after consultation with the instructor.
580. PROUST AND GIDE (3)

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\*No graduate credit is given for this course.



ITALIAN (IT)

571. SEMINAR IN ITALIAN LITERATURE (3-6) Lectures on methods of research. Students will pursue common and individual investigations in fields selected after consultation with the instructor.

PORTUGUESE (PORT)

571. SEMINAR IN PORTUGUESE LITERATURE (3-6)

SPANISH (SPAN)

401. THE GOLDEN AGE (3)  
 402. DRAMA OF THE GOLDEN AGE (3)  
 403. DON QUIXOTE (3)  
 404. OLD SPANISH LANGUAGE AND LITERATURE (3)  
 405. SPANISH DRAMA OF THE 19TH CENTURY (3)  
 407. THE SPANISH NOVEL OF THE 19TH CENTURY (3)  
 408. THE CONTEMPORARY SPANISH NOVEL (3)  
 409. INTRODUCTION TO LATIN-AMERICAN LITERATURE (3)  
 410. INTRODUCTION TO LATIN-AMERICAN LITERATURE (3)  
 411. MEXICO: ITS LANGUAGE AND LITERATURE (3)  
 417. SPANISH LITERATURE IN THE ROMANTIC PERIOD (3)  
 421. THE TEACHING OF ROMANCE LANGUAGES (3)  
 471. PROBLEMS IN SPANISH LITERATURE (3-6)  
 490. ADVANCED COMPOSITION AND CONVERSATION (3)

- \*1G. ELEMENTARY SPANISH FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.

501. GOLDEN AGE LITERATURE (3) Nature and development of Spanish literature of the 16th and 17th centuries.  
 538. THE GENERATION OF 1898 (3) Principal works and intellectual trends of the period with special emphasis on Unamuno.  
 549. MODERNISMO (3) The movement, its antecedents, and its followers, with special emphasis on Rubén Darío.  
 552. MEDIEVAL SPANISH LITERATURE (3) Familiarizes the student with Old Spanish texts.  
 565. LOPE DE VEGA (3)  
 567. CERVANTES AND HIS WORKS (3)  
 571. SEMINAR IN SPANISH LITERATURE (3-12) Lecture on methods of research. Students will pursue common and individual investigations in fields selected after consultation with the instructor.

ROMANCE LITERATURE (R LIT)

544. NEOCLASSICISM IN THE ROMANCE LITERATURES (3) The neoclassical movement in the Romance literatures, with emphasis on French and Spanish.  
 545. ROMANTICISM IN THE ROMANCE LITERATURES (3) The Romantic movement in the Romance literatures, with emphasis on French and Spanish.

\*No graduate credit is given for this course.

## ROMANCE LANGUAGES

546. MEDIEVAL ROMANCE LITERATURES (3) Medieval writings in the Romance literatures, with emphasis on French and Spanish.
547. REALISM IN THE ROMANCE LITERATURES (3) The Realistic movement in the Romance literatures, with emphasis on French and Spanish.
554. THE RENAISSANCE IN THE ROMANCE LITERATURES (3) The effect of the Renaissance on the Romance literatures, with emphasis on French and Spanish.

## ROMANCE PHILOLOGY (R PH)

551. ROMANCE PHILOLOGY (3)
558. ADVANCED LINGUISTICS AND PHONETICS OF THE ROMANCE LANGUAGES (3)
573. THEORY AND TECHNIQUES OF TEACHING THE ROMANCE LANGUAGES (1-2)
574. METHODS AND BIBLIOGRAPHY IN ROMANCE LANGUAGES AND LITERATURES (1-2)

## RURAL SOCIOLOGY

MACKLIN E. JOHN

*Head of the Department of Agricultural Economics and Rural Sociology*  
1 Weaver Building

*Degrees Conferred:* Ph.D., M.S., M.Agr.

*Graduate Faculty:* Professors Bonser, Brown, Buck, and John; Associate Professors Bylund and Copp; Assistant Professors Fliegel and Freeman.

The entering student in the master's program should have as prerequisites 3 credits in rural sociology, 3 credits in sociology, and 3 additional credits in either field. If he does not have these prerequisites, he may take them at this University during the early part of his master's program.

## RURAL SOCIOLOGY (R SOC)

402. CONSUMER BEHAVIOR AND THE AGRICULTURAL INDUSTRY (3) *Mr. Bylund*
452. RURAL ORGANIZATION (3) *Mr. Copp*
459. RURAL SOCIAL PSYCHOLOGY (3)
501. DEVELOPMENT OF RURAL SOCIOLOGY (2) Historical development with emphasis on American rural sociology. *Mr. Buck*
502. ADVANCED RURAL SOCIOLOGY (3) Structure and functioning of rural society; evaluation of theoretical systems.
510. RURAL MIGRATION (2) Rural migration research and theory; application to governmental and community problems.
512. NATIONAL FARM ORGANIZATIONS (2) National farm organizations as social systems. Prerequisite: R.Soc. 452. *Mr. Buck*
513. SOCIOLOGY OF CONSUMER BEHAVIOR (2) Sociological theory and research pertaining to consumer behavior. *Mr. Bylund*
514. VALUES IN RURAL SOCIETY (2) Values as dynamic forces in rural society.
515. EXTENSION ORGANIZATION AND METHODS (2) Agricultural and home economics extension as a social system with emphasis on techniques of organization and program development. *Mr. Brown*

516. CHANGE IN RURAL SOCIETY (2) Social change in rural society emphasizing prediction and control of the change process. *Mr. Fliegel*
551. RURAL SOCIOLOGY SEMINAR (1-6) Prerequisite: 6 credits in rural sociology, sociology, or psychology.

## SANITARY ENGINEERING

(See page 82, Civil Engineering.)

## SECONDARY EDUCATION

JAMES H. MOYER, *Head of the Department*  
207A Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors McGarey, Moyer, Patrick, Remaley, and Veon; Associate Professors Fowler and Kozak.

Graduate degree programs in the department are provided primarily for the advanced preparation of competent public school teachers.

In general, candidates for the M.Ed. in secondary education must have 18 approved undergraduate credits in education and psychology including practice teaching in an area appropriate to the major, and aptitude for and interest in advanced professional preparation. Applicants are encouraged to have had at least two years of successful teaching experience.

While candidates are required to specialize in secondary education, they are encouraged to acquire a general education in the social sciences, the behavioral sciences, and the humanistic foundations.

The M.Ed. degree may be earned, in general, in those fields outside of secondary education for which a master's degree has been approved, provided such a professional program is appropriate. Thus, for example, the M.Ed. degree may be earned with a major in English or chemistry. These programs require an approved minor in educational foundations.

### SECONDARY EDUCATION (SEC ED)

400. THE SCIENTIFIC DIRECTION OF LEARNING ACTIVITIES (2-4)
426. TEACHING MATHEMATICS IN THE SECONDARY SCHOOLS (4)
433. TEACHING SOCIAL STUDIES IN THE SECONDARY SCHOOLS (4)
436. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE SECONDARY SCHOOL (3)
437. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE SECONDARY SCHOOL (3)
438. TEACHING SCIENCE IN THE SECONDARY SCHOOLS (4)
443. READING PROBLEMS IN THE SECONDARY SCHOOL (2-3)
445. (El.Ed. 445) TECHNIQUES IN REMEDIAL READING (2-6)
451. SECONDARY EDUCATION IN AMERICA (3)
453. TEACHING ENGLISH IN THE SECONDARY SCHOOLS (4)
454. EXTRACURRICULAR ACTIVITIES IN THE JUNIOR AND SENIOR HIGH SCHOOL (2-3)



## SECONDARY EDUCATION

456. PRINCIPLES AND PROBLEMS IN BUSINESS EDUCATION (1-3)
459. IMPROVEMENT OF INSTRUCTION IN BUSINESS SKILL SUBJECTS (1-3)
460. CURRICULUMS IN BUSINESS EDUCATION (3)
461. IMPROVEMENT OF INSTRUCTION IN BASIC BUSINESS SUBJECTS (3)
462. TEACHING OF SHORTHAND AND TYPEWRITING (3)
463. TEACHING OF BOOKKEEPING (3)
466. TEACHING OF OFFICE PRACTICE (3)
467. TEACHING OF SHORTHAND (2-3)
468. TEACHING OF TYPEWRITING (2-3)
472. MEASUREMENT OF ACHIEVEMENT IN THE SECONDARY SCHOOL (2-3)
497. WORKSHOP IN SELECTED STUDIES IN SECONDARY EDUCATION (1-6)
510. INTERNSHIP IN SECONDARY SCHOOL TEACHING (3-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
511. INTERNSHIP IN BUSINESS EDUCATION SUPERVISION (3-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
525. MODERN TENDENCIES IN EDUCATIONAL METHOD (2-3) Study of science supporting dynamic instruction; principles of teaching as guides; analysis of modern procedures; understanding of learning; substance versus plans. Prerequisite: 12 credits of undergraduate work in education.
532. SUPERVISION OF STUDENT TEACHERS (3) A course in supervision for master teachers, department heads, and college teachers with supervisory responsibilities in teacher education. Prerequisite: teaching experience and 18 credits in education, including at least 5 in methods.
537. (Bot. 537, Zool. 537) WORKSHOP IN THE BIOLOGICAL SCIENCES (3) Projects designed for teachers of biology in the secondary schools.
546. (El.Ed. 546) SEMINAR ON READING INSTRUCTION (3-6) Research procedures and materials in reading readiness, word perception, basic reading skills, vocabulary development, reading in content subjects. Prerequisite: Sec.Ed. 443 or El.Ed. 443.
550. PROBLEMS IN MODERN SECONDARY EDUCATION (1-4) Historical, psychological, social, and economic factors influencing secondary education; required as basic course of all graduate students in secondary education. Prerequisite: secondary school teaching.
551. SEMINAR IN CONTEMPORARY ISSUES IN THE SECONDARY SCHOOL CURRICULUM (2-3) Principles and philosophy of curriculum construction. Each student works out an individual problem in the secondary school curriculum. Prerequisites: 12 credits in education and psychology, and teaching experience.
552. SEMINAR IN CONTEMPORARY ISSUES IN LABORATORY STUDIES IN THE APPLICATION OF EDUCATIONAL METHOD (2-3) Analysis and application of outstanding studies in secondary education; integration of results of educational research with public school procedures. Prerequisites: 12 credits in education and psychology, and teaching experience.
553. SEMINAR IN CONTEMPORARY ISSUES IN THE ORGANIZATION AND ADMINISTRATION OF SECONDARY EDUCATION (2-3) Problems in the reorganization of secondary education, with particular reference to philosophy, organization, and teaching problems of the junior high school. Prerequisites: 12 credits in education and psychology, and teaching experience.

## SECONDARY EDUCATION

556. (El.Ed. 556) **READING CLINIC PRACTICE: ANALYSIS OF READING DISABILITIES (3-6)** Analysis of extreme reading disabilities and recommended procedures; experience in preparation of case reports. Prerequisite: Sec.Ed. 445 or El.Ed. 444.
575. **ADMINISTRATION AND SUPERVISION IN BUSINESS EDUCATION (3)** Work of administrators, supervisors, and others responsible for improvement of instruction in business education; use of vocational testing; job analysis. Prerequisite: 6 credits in secondary education.
576. **INTRODUCTION TO RESEARCH IN BUSINESS EDUCATION (3)** Methods of research in business education; opportunity to compile annotated bibliographies on current problems; analysis and evaluation of significant research.
577. **EVALUATION OF RESEARCH AND EMPIRICAL LITERATURE IN BUSINESS EDUCATION (3)** Application of evaluation methods to current literature in business education; special attention to research studies. Prerequisite: Sec.Ed. 576.
578. **SEMINAR IN BUSINESS EDUCATION (1-6)** Intended for graduate students preparing theses or final documents, or for those working on special studies in business education. Prerequisite: Sec.Ed. 577.
585. **CURRICULUM CONSTRUCTION (2-3)** Functions of administrators, supervisors, teachers, pupils, and laymen in curriculum building to meet pupil and community needs.
594. **SEMINAR IN SECONDARY EDUCATION (1-3)** Conferences and discussions designed to meet the need for special study of particular fields in secondary education. Prerequisite: 12 credits of graduate work in education.
597. **WORKSHOP IN CURRENT EDUCATIONAL PROBLEMS IN SECONDARY EDUCATION (1-6)** For administrators, supervisors, experienced secondary teachers, guidance workers; administrative, supervisory, and instructional problems involved in an emerging educational program. Prerequisite: 12 credits of graduate work in education.
598. **PROBLEMS, PROJECTS, AND AREA STUDIES IN SECONDARY EDUCATION (1-6)** Independent work in the study of topics in secondary education or the development of new curriculums, materials, or procedures for teaching. Prerequisites: 12 credits of graduate work in education and approval of the department head.

## SOCIAL STUDIES

NEIL A. McNALL

*Chairman of the Committee on Social Studies*  
115 Sparks Building

*Degree Conferred: M.Ed.*

This program, designed to meet the needs of secondary school teachers, consists of at least 24 credits chosen from economics, history, human geography, political science, and sociology, and a minor of at least 6 credits in educational foundations. A candidate is expected to complete at least 3 credits in each of four fields and not more than 12 credits in one of them.

To undertake graduate work in this field, the student must have had solid preparation in the basic courses in history, political science, economics, and sociology; and he should have had some advanced undergraduate work in at least one of these fields. He should be certified for teaching social studies, and ideally he should have had teaching experience in this field as well.



# SOCIOLOGY

WILLIAM G. MATHER

*Head of the Department of Sociology and Anthropology*  
239 Sparks Building

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Professors Bernard, Clark, Coutu, Mather, F. R. Matson, and Mook; Associate Professors Baker, Dansereau, Dupree, M. B. Matson, and Theodorson.

Undergraduate preparation must include 12 credits in sociology and at least 7 in other social sciences, with a broad background in the arts and sciences preferred. Students of exceptional ability who are slightly deficient in undergraduate preparation may be accepted, on condition that they make up their deficiency in courses without degree credit.

## SOCIOLOGY (SOC)

- 400. SOCIOLOGICAL PRINCIPLES (3)
- 401. SOCIAL INSTITUTIONS (3)
- 403. ADVANCED SOCIAL PSYCHOLOGY (3) Mr. Coutu
- 405. SOCIAL ADJUSTMENT IN WORK LIFE (3)
- 408. SOCIAL ECOLOGY (3) Mr. Theodorson
- 413. METHODS AND TECHNIQUES OF SOCIAL RESEARCH (1-6) Mr. Dansereau
- 418. THE DEVELOPMENT OF SOCIAL THOUGHT (3)
- 423. POPULATION RESEARCH (3)
- 424. SOCIAL CHANGE (3)
- 426. INTRODUCTION TO PUBLIC WELFARE (3)
- 427. SOCIAL CASE WORK (3)
- 429. SOCIAL STRATIFICATION (3)
- 431. COMMUNICATION AND MASS SOCIETY (3)
- 450. COMMUNITY ORGANIZATION (3)
- 454. INDUSTRY AND THE COMMUNITY (3)
- 455. OCCUPATIONS AND PROFESSIONS (3) Mr. Dansereau
- 470. USE OF STATISTICS IN SOCIOLOGY (3) Mr. Clark
- 499. FOREIGN STUDY IN SOCIOLOGY (2-6)
  
- 500. SEMINAR IN GROUP THEORY (1-3) The group as a unit of social structure and action.
- 501. ANALYTICAL SOCIAL THEORY (3) The nature, general types, and origins of sociological theory; problems in the logic of sociological inquiry.
- 502. CONTEMPORARY SOCIOLOGICAL THEORY (3) Survey of leading sociological works written during the last five decades.
- 503. RESEARCH SEMINAR IN SOCIAL PSYCHOLOGY (3-6) Design and conduct of research in areas of mutual interest in social psychology. Mr. Coutu
- 505. CURRENT SOCIAL THEORY (3) Current contributions to social theory; their relations to each other and to the larger theoretical structure. Mr. Theodorson
- 506. SEMINAR IN SOCIOLOGICAL THEORY (3-6)
- 510. FIELD WORK IN SOCIOLOGY (1-6)
- 513. SEMINAR IN SOCIOLOGICAL RESEARCH PROBLEMS: A. RESEARCH TECHNIQUES; B. CURRENT RESEARCH (3-6) Prerequisite: 3 credits in statistics. Mr. John



515. SEMINAR IN COMMUNITY STUDIES (3) Mrs. Bernard
523. POPULATION PROBLEMS (1-6)
525. SEMINAR IN SOCIOLOGY (1-6) Research problems in theoretical and applied sociology.
530. RESEARCH ON MARRIAGE AND THE FAMILY (3) Training in methods and techniques of research in family relations. Experimental, statistical, and comparative studies are carried out, individually or co-operatively. Prerequisite: 3 credits of previous work in this field. Mrs. Bernard
555. INDUSTRIAL SOCIOLOGY (3) Research methods and techniques in industrial sociology; current research, unexplored areas.
572. METHODS OF SAMPLING (3) Application of sampling techniques to sociological research. Mr. Clark

## SOLID STATE TECHNOLOGY

RUSTUM ROY

*Chairman of the Committee on Solid State Technology*  
121 Mineral Sciences Building

*Degrees Conferred:* Ph.D., M.S.

The aim of this program is to provide an opportunity for the student interested in the structure, properties, and behavior of solid materials to obtain an integrated program of courses encompassing both the fundamentals of chemistry, physics, and mathematics and their technological and engineering applications.

The subject matter, taught by various departments, is grouped into four areas: (1) the structure of solids, (2) theory related to the solid state, (3) properties of solids, and (4) reactions of solids.

Course work should be so distributed that one area is encompassed in depth while a substantial number of credits is chosen from any combination of the other areas. Thesis research on various aspects of the solid state may be conducted in appropriate departments in the Colleges of Chemistry and Physics, Engineering and Architecture, and Mineral Industries.

Entering students should hold a bachelor's degree in chemistry, physics, mathematics, geological science, engineering, ceramics, or metallurgy, or in a closely related field that will have included mathematics at least through integral calculus and a minimum of one year of physics and one year of chemistry. They should be specifically interested in an interdisciplinary program of study and research.

## SPEECH

ROBERT T. OLIVER, *Head of the Department*  
305 Sparks Building

*Degrees Conferred:* Ph.D., D.Ed., M.A., M.Ed.

*Graduate Faculty:* Professors McDonald, Oliver, Schug, Siegenthaler, and Zelko; Associate Professors Brubaker, Carter, Fife, Frick, Holtzman, Nelson, and White; Assistant Professor Dunham.

## SPEECH

The student may specialize in speech arts (interpretation, drama, theatre); radio and television; rhetoric and public address (including discussion, communication, teaching of speech); speech science (voice, diction, phonetics, general semantics); or speech pathology and audiology.

The minimum undergraduate preparation required is 12 credits in speech, including a beginning public speaking course and speech science with group discussion and persuasion. Students who cannot meet this requirement in full may be admitted, but must make up their deficiencies without credit toward the graduate degree. Spch. 400 and Spch. 502 are required of all graduate students who do not have their equivalents.

### SPEECH (SPCH)

- |                                                                                                                                                                                                                                                                                                                                      |               |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 400. TEACHING OF SPEECH (3)                                                                                                                                                                                                                                                                                                          | Mr. Schug     |
| 402. GENERAL SEMANTICS (3)                                                                                                                                                                                                                                                                                                           | Mr. Carter    |
| 410. ENGLISH PHONETICS AND PRONUNCIATION (3)                                                                                                                                                                                                                                                                                         | Mr. Brubaker  |
| 412. SPEECH COMPOSITION (3)                                                                                                                                                                                                                                                                                                          | Mr. Shoemaker |
| 415. EXPERIMENTAL AND APPLIED PHONETICS (3)                                                                                                                                                                                                                                                                                          | Mr. Brubaker  |
| 425. ADVANCED PRINCIPLES OF RADIO SPEECH (3)                                                                                                                                                                                                                                                                                         | Mr. Nelson    |
| 431. ANATOMY AND PHYSIOLOGY OF THE EAR AND VOCAL MECHANISMS (3)                                                                                                                                                                                                                                                                      | Mr. Brubaker  |
| 435. TELEVISION AND RADIO ORGANIZATION (3)                                                                                                                                                                                                                                                                                           | Mr. Nelson    |
| 437. ADVANCED PRINCIPLES OF TELEVISION SPEECH (3)                                                                                                                                                                                                                                                                                    | Mr. Nelson    |
| 445. CONTEMPORARY PUBLIC ADDRESS (3)                                                                                                                                                                                                                                                                                                 |               |
| 450. DISCUSSION: RESEARCH AND THEORY (3)                                                                                                                                                                                                                                                                                             | Mr. Zelko     |
| 490. PSYCHOLOGY OF SPEAKING AND LISTENING (3)                                                                                                                                                                                                                                                                                        | Mr. Holtzman  |
|                                                                                                                                                                                                                                                                                                                                      |               |
| 500. SEMINAR IN AMERICAN ORATORY (2-4) History of American oratory, with application of critical standards to the work of specific orators. Prerequisite: 6 credits in speech, including Spch. 200.                                                                                                                                  | Mr. Oliver    |
| 502. RESEARCH METHODS IN SPEECH (3) Research design, thesis proposals, and background for research in graduate study. Prerequisite: 6 credits at the 400 or 500 level in speech, clinical speech, or theatre arts.                                                                                                                   | Mr. Carter    |
| 505. HISTORICAL DEVELOPMENT OF SPEECH THEORY AND CRITICISM (2-4) Classical theories of speech-making from the earliest beginnings to the fall of the Roman Empire.                                                                                                                                                                   | Mr. White     |
| 506. HISTORICAL DEVELOPMENT OF SPEECH THEORY AND CRITICISM (2-4) Theories of speech-making from the Renaissance to the present.                                                                                                                                                                                                      | Mr. White     |
| 508. SEMINAR IN BRITISH ORATORY (2-4) History of British oratory; application of critical standards to the work of selected orators.                                                                                                                                                                                                 | Miss Fife     |
| 510. SEMINAR IN SPEECH PEDAGOGY (2-4) Advanced knowledge, theories, and principles, together with their philosophical, scientific, clinical, artistic, and educational implications for the teacher of speech. Prerequisite: Spch. 502 and 9 additional credits at the 400 or 500 level in speech, clinical speech, or theatre arts. | Mr. Carter    |
| 520. SEMINAR IN SPEECH SCIENCE (2-4) Seminar in physical and physiological bases of speech and voice; introduction to laboratory techniques used in speech research. Prerequisite: 9 credits in speech, speech education, or psychology.                                                                                             | Mr. Brubaker  |
| 540. SEMINAR IN PROBLEMS OF TELEVISION AND RADIO (2-4) Study and research in television and radio as they pertain to programming, production, relation to society, and speech.                                                                                                                                                       | Mr. Nelson    |

550. SEMINAR IN ORAL PERSUASION (2-4) Theory and devices of persuasion; analysis of persuasive discourse. Prerequisite: 6 credits in speech including Spch. 200.  
Mr. Holtzman
552. ORAL COMMUNICATION IN INDUSTRY, BUSINESS, AND GOVERNMENT (2-4) Needs, practices, and methods in American industry, business, and government; methods of training adults in oral communication skills.  
Mr. Zelko
555. SPEECH COMMUNICATION: PROBLEMS AND PRINCIPLES (2-4) Prevalent theories of speech influence.  
Mr. Oliver
560. PUBLIC ADDRESS (2-4) Discussion and criticism of speech outline, manuscript, content, composition, and delivery. Prerequisite: 6 credits in speech including Spch. 200.  
Mr. Schug
575. RESEARCH PROBLEMS IN SPEECH (1-12) Advanced research on an individual basis in oratorical criticism, discussion techniques, persuasion, pedagogy, phonetics, speech science, and speech pathology. Prerequisite: 12 credits in speech or speech education.

## STATISTICS

JAMES B. BARTOO, *Chairman of the Committee on Statistics*  
231 McAllister Building

No advanced degree is offered in this field, but a candidate with a major in another field may choose a minor in statistics upon approval by his major department.

This minor is intended to facilitate development of a coherent program of study in this vital branch of the scientific method. The candidate will be expected to become conversant with the broad field of statistics and to become reasonably proficient in the statistical methods particularly useful in the subject-matter areas of his major field. The member of the candidate's committee representing the minor in statistics will have responsibility for determining course work acceptable in satisfying requirements for the minor.

The minimum requirements for a minor for a master's degree are 3 credits in mathematical statistics and 6 in applied statistics. For a doctor's degree a minimum of 15 credits in statistics is required for a minor, of which at least 6 must be mathematical statistics and at least 6 must be applied statistics.

Courses in mathematical statistics are: Math. 409, 410, 542, and 543.

Courses in applied statistics are: Ag. 400; A.B.Ch. 515; Ag.Ec. 505; Ag.Ed. 521v; Agro. 512, 545; B.S. 500, 501; Econ. 510; Ed.Ser. 490, 590; For. 450; I.E. 423; Meteo. 450; Min. 513, 514, 526; Psy. 415, 515, 527; and Soc. 470, 572.

## THEATRE ARTS

WALTER H. WALTERS, *Head of the Department*  
201 Schwab Auditorium

*Degree Conferred:* M.A.

*Graduate Faculty:* Professors Neusbaum, Smith, and Walters; Associate Professors Reifsneider and Yeaton.



## THEATRE ARTS

Under certain circumstances the Ph.D. degree is offered by the Department of English with specialization in drama and minor work in theatre arts.

A course in basic acting, one in directing, and one in theatre crafts, or their equivalents, are required for admission. In addition, the student must have had 12 credits divided between speech and the arts (including music, sculpture, painting, architecture, and other courses in which art is practiced); or a minimum of 9 credits in one of these; or a minimum of 9 credits in English and literature, including at least 6 in dramatic literature, or 3 in dramatic literature and 3 in advanced creative writing.

### THEATRE ARTS (THEA)

- 404. STYLES OF ACTING (3-6)
- 412. ADVANCED SCENE DESIGN (3)
- 413. STAGE LIGHTING (3)
- 415. THEATRE ORGANIZATION AND MANAGEMENT (3)
- 421. ADVANCED PLAYWRITING (3)
- 431. HISTORY OF THE THEATRE (3)
- 433. DANCE FOR THE THEATRE (3)
- 442. CREATIVE DRAMATICS WITH CHILDREN (3)
- 443. MARIONETTES AND PUPPETRY (3)
- 451. DIRECTING (3)
- 452. CENTRAL STAGING (3)
- 470. THEATRE PRODUCTION (3-6)
- 481. TELEVISION DRAMA (3)
  
- 501. PROBLEMS OF DIRECTING (3-6) Seminar in problems of production with particular stress on direction. Students will direct plays under staff supervision.
- 502. SEMINAR IN THE TECHNICAL PROBLEMS OF DRAMATIC PRODUCTION (3-6) Prerequisite: Thea. 11.
- 504. SEMINAR IN STYLES OF ACTING (3-6) Practical work required of each student.
- 506. EVALUATION AND APPRECIATION OF MODERN DRAMATIC ENTERTAINMENT (3) Prerequisites: Thea. 1, 61.
- 507. SEMINAR IN FUNDAMENTAL THEORIES OF THEATRE AND DRAMA (3-6)
- 521. PLAYWRITING (3-6) Prerequisites: Thea. 21, 421.

## VOCATIONAL INDUSTRIAL EDUCATION

(See page 123, Industrial Arts Education and Vocational Industrial Education.)

## WILDLIFE MANAGEMENT

*Consult* BERTIL G. ANDERSON  
212 Frear Laboratory

The M.S. degree is offered in the field of wildlife management. Candidates select courses for this major from a number of related fields.

# ZOOLOGY

BERTIL G. ANDERSON

*Head of the Department of Zoology and Entomology*  
212 Frear Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Anderson, Anthony, and Davis; Associate Professors Boyle, Cooper, and Wood; Assistant Professors Bellis and Smyth.

Students may specialize in animal behavior, bioacoustics, ecology, endocrinology, fishery biology, genetics, histology, ichthyology, invertebrate zoology, invertebrate physiology, or wildlife management.

In order to undertake graduate work in zoology, students are required to have had 24 credits in zoology and related biological sciences; and they should have had chemistry through organic chemistry. Courses in physics and mathematics are also advantageous. A limited deficiency can be made up without degree credit while pursuing graduate work.

## ZOOLOGY (ZOO)

- |                                                                                                                                                                                                                                                                                  |                                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| 401. (P.H. 401, Psy. 401) ANIMAL BEHAVIOR (3)                                                                                                                                                                                                                                    | <i>Mr. Hale</i>                |
| 403. (Ent. 403) SYSTEMATICS (3)                                                                                                                                                                                                                                                  | <i>Mr. Boyle</i>               |
| 405. (Bot. 405) GENERAL CYTOLOGY (3)                                                                                                                                                                                                                                             | <i>Mr. Grun</i>                |
| 408. MAMMALOGY (4)                                                                                                                                                                                                                                                               | <i>Mr. Davis</i>               |
| 410. GENERAL LIMNOLOGY (3)                                                                                                                                                                                                                                                       | <i>Mr. Cooper</i>              |
| 415. THE LITERATURE OF ZOOLOGY (1)                                                                                                                                                                                                                                               | <i>Mr. Anderson</i>            |
| 416. THE METHODS OF RESEARCH IN ZOOLOGY (2)                                                                                                                                                                                                                                      | <i>Mr. Anderson</i>            |
| 417. INVERTEBRATE ZOOLOGY (3)                                                                                                                                                                                                                                                    |                                |
| 419. GENERAL ANIMAL ECOLOGY (3)                                                                                                                                                                                                                                                  | <i>Mr. Bellis</i>              |
| 421. COMPARATIVE ANATOMY OF VERTEBRATES (4)                                                                                                                                                                                                                                      | <i>Miss Lehmann</i>            |
| 422. (Bot. 422) ADVANCED GENETICS (3)                                                                                                                                                                                                                                            | <i>Mr. Wright</i>              |
| 432. HUMAN PARASITOLOGY (3)                                                                                                                                                                                                                                                      |                                |
| 433. (Bot. 433) GENETICS, EUGENICS, AND EVOLUTION FOR TEACHERS (3)                                                                                                                                                                                                               | <i>Messrs. Wright and Grun</i> |
| 437. HISTOLOGY (4)                                                                                                                                                                                                                                                               | <i>Mr. Anthony</i>             |
| 440. EMBRYOLOGY (4)                                                                                                                                                                                                                                                              | <i>Miss Lehmann</i>            |
| 441. ESSENTIALS OF HUMAN PHYSIOLOGY FOR TEACHERS (3)                                                                                                                                                                                                                             |                                |
| 444. ZOOLOGICAL PROBLEMS (1-6)                                                                                                                                                                                                                                                   |                                |
| 448. ORNITHOLOGY (3)                                                                                                                                                                                                                                                             | <i>Mr. Wood</i>                |
| 450. ICHTHYOLOGY (3)                                                                                                                                                                                                                                                             | <i>Mr. Cooper</i>              |
| 461. ANIMAL PARASITOLOGY (3)                                                                                                                                                                                                                                                     |                                |
|                                                                                                                                                                                                                                                                                  |                                |
| 505. (Bot. 505) CYTOLOGY AND CYTOGENETICS (3) Chromosome mechanism of heredity; relationship between plant and animal evolution and breeding and changes in chromosomes; cytological and cytochemical techniques. Prerequisite: Zool. (Bot.) 405 or 422. Spring term, odd years. | <i>Mr. Grun</i>                |
| 508. ADVANCED PARASITOLOGY (3) Advanced work on the structure, life cycle, and control of parasites.                                                                                                                                                                             |                                |
| 509. TECHNIQUES IN WILDLIFE MANAGEMENT (2) Evaluation of procedures designed to manage populations of game and fish; elements of statistics of birth and mortality rates; census methods. Fall term.                                                                             | <i>Mr. Davis</i>               |

## ZOOLOGY

512. SEMINAR (1) Review of current zoological literature. Required of graduate students majoring in zoology and entomology. Prerequisite: 12 credits in zoology or entomology.
520. SPECIAL TOPICS (1-6)
524. (Bot. 524) SEMINAR IN GENETICS (1 per term) *Mr. Wright*
525. HISTORY OF BIOLOGY (3) Historical development of biological knowledge and theories. Fall term.
528. (Bot. 528) POPULATION GENETICS (3) Factors affecting gene frequency, genotype frequency, genotype-environmental interaction, and genetic relationship in natural and artificial populations. Winter term, even years.
533. (Bot. 533) PROBLEMS IN GENETICS (2-6) Problems to suit needs of individual students; conferences and laboratory work. Prerequisite: Zool. (Bot.) 422. *Messrs. Wright and Grun*
537. (Bot. 537, Sec.Ed. 537) WORKSHOP IN THE BIOLOGICAL SCIENCES (3) Projects designed for teachers of biology in the secondary schools. Summer term.
541. COMPARATIVE PHYSIOLOGY (3) Dynamics of vital processes as shown in members of the animal kingdom. Prerequisites: Zool. 26; A.B.Ch. 1; A.B.Ch. 425 or Zool. 437. Winter term. *Mr. Smyth*
546. PRINCIPLES OF ANIMAL POPULATIONS (3) Ecological laws governing population growth and decline; reproductive and mortality rates; predation and composition as limiting factors. Fall term. *Mr. Davis*
551. FISHERIES MANAGEMENT (3) Basic principles underlying management of inland waters for fish production. Prerequisite: Zool. 450. Summer term, even years. *Mr. Cooper*
581. ADVANCED INVERTEBRATE ZOOLOGY (3) Morphology, physiology, taxonomy, and life histories of invertebrate animals.
582. (P.H. 582, Psy. 582) RESEARCH IN ANIMAL BEHAVIOR (2-6 per term) Research in special areas of animal behavior involving field and laboratory work. Prerequisite: Zool. (P.H., Psy.) 401; or Psy. 403. *Messrs. Hale, Schein, and Davis*
583. GENERAL ENDOCRINOLOGY (2) Anatomy and physiology of the organs of internal secretion; role of hormones in metabolism and development. Spring term, even years. *Mr. Anthony*
587. BIOLOGY OF SEX (2) Hereditary and embryological aspects, problems in gonadal differentiation, cyclic reproductive phenomena, actions of the hormones. Spring term, odd years. *Mr. Anthony*



## Part II

### *Other Elective Graduate Courses*

The following courses are in fields in which neither major nor minor work is offered at this institution. The courses, however, carry graduate credit and, with the approval of the major department, may be applied toward the requirements for a degree either as elective courses or as a part of a general studies program. The usual restrictions upon the use of 400 series courses in degree programs apply to these courses.

#### AGRICULTURE, GENERAL (AG)

400. INTRODUCTORY BIOMETRY (3)

*Mr. Bennett*

#### ASTRONOMY (ASTRO)

430. GENERAL ASTRONOMY FOR TEACHERS (3)

470. SOLAR PHYSICS (3)

490-491. INTRODUCTION TO ASTROPHYSICS (3 each)

#### BROADCASTING (BRCST)

482. CREATIVE BROADCASTING (3)

#### ENGINEERING (ENGR)

422. ORDNANCE ENGINEERING: TORPEDO ENGINEERING (3)

431. DIGITAL COMPUTER PROGRAMMING (3)

450. PATENT FUNDAMENTALS (3)

500. SPECIAL TOPICS IN ENGINEERING (1-3)

531. ADVANCED DIGITAL COMPUTER PROGRAMMING (3) Nonnumerical applications; symbol manipulation, syntactical analysis, and translation of artificial languages; heuristic methods, learning mechanisms, artificial intelligence. Prerequisite: Engr. 431.

#### GREEK (GREEK)

421. GREEK TRAGEDY (3)

422. GREEK COMEDY (3)

500. GREEK COMPOSITION (2) Translation of extended narrative passages into Attic Greek; thorough review of forms and syntax; attention to rhetorical elements of the language.

#### HEALTH EDUCATION (HL ED)

403. FIRST AID, ATHLETIC CONDITIONING AND TRAINING (3)

406. RECENT DEVELOPMENTS IN SCHOOL HEALTH EDUCATION (3)

411. PRINCIPLES AND METHODS OF TEACHING SAFETY EDUCATION (3)

456. ADVANCED TECHNIQUES IN RURAL SCHOOL HEALTH (3)

## HEALTH EDUCATION

501. HEALTH IMPLICATIONS IN THE GROWTH AND DEVELOPMENT OF SCHOOL CHILDREN (3) Child growth and development emphasis for teachers; medical inspection and examination; preschool program; early habit formations; behavior problems; co-operation of parents, teachers, and children. Prerequisite: Hl.Ed. 215.
505. ADVANCED TECHNIQUES IN HEALTH EDUCATION (3) Prerequisites: Hl.Ed. 215, Psy. 437.
572. TESTS AND MEASUREMENTS IN HEALTH EDUCATION (3) Critical study, evaluation, and demonstration of tests and measures of health education; statistical computations of data. Prerequisites: Ph.Ed. 490, Hl.Ed. 215.

## INTERNATIONAL UNDERSTANDING (INT U)

400. WORLD AFFAIRS AND INTERNATIONAL UNDERSTANDING (3-6)

## LABOR-MANAGEMENT RELATIONS (L M R)

411. TRADE UNION ADMINISTRATION (3)  
421. LABOR EDUCATION (3)

## LATIN (LATIN)

428. LUCRETIVS (3) *Mr. Krauss*  
429. QUINTILIAN (3) *Mr. Krauss*  
431. JUVENAL (3) *Mr. Krauss*  
436. FUNCTIONAL PROBLEMS IN LATIN (3)
500. LATIN LITERATURE (3) Lectures and collateral readings on the major forms of Latin literature; readings in the original Latin to supplement the lectures. *Mr. Krauss*
501. ROMAN RELIGION AND PHILOSOPHY (3) Development of religious concepts at Rome from primitive Italic origins to the advanced forms that culminated in Roman Stoicism. *Mr. Krauss*
502. LATIN EPIGRAPHY (3) Lectures and readings on Roman inscriptions; illustrative exercises. *Mr. Krauss*
503. LATIN PALEOGRAPHY (3) The Latin alphabet, writing materials, Roman book and cursive hands; illustrative exercises. *Mr. Krauss*
504. ROMAN TOPOGRAPHY (3) Physical development of the city of Rome, its walls, aqueducts, bridges, streets, forums, public buildings, temples, etc.; building materials and methods of construction. *Mr. Krauss*
510. LATIN SEMINAR (3) *Mr. Krauss*
518. LATIN RESEARCH (1-3) Prosecution of an assigned problem under the guidance of a member of the department.

## LIBERAL ARTS (L A)

- 500-501. FUNDAMENTALS OF LINGUISTICS (3 each) Interrelated problems of language discussed from four points of view: modern structural linguistics, historical linguistics, social psychology, and philosophy.

## LIBRARY SCIENCE (L SC)

403. INTERMEDIATE DICTIONARY CATALOGING AND SUBJECT HEADINGS (3)  
 405. INTERMEDIATE REFERENCE WORK AND BIBLIOGRAPHY (3)  
 407. SPECIAL PROBLEMS IN SCHOOL LIBRARY SERVICE (6)

## MINERAL SCIENCES (MN SC)

411. INSTRUMENT TECHNIQUES APPLIED TO MINERAL SCIENCE PROBLEMS (1-3)  
     Unit A. *X-ray Diffraction*  
     Unit B. *Electron Microscopy*  
     Unit C. *Spectroscopy*
510. X-RAY AND ELECTRON DIFFRACTION ANALYSIS AS APPLIED TO MINERALS AND METALS (2) Prerequisite: Phys. 203 or 204. *Mr. Brindley*
520. ELECTRON MICROSCOPY IN MINERAL SCIENCE RESEARCH (1-4) Prerequisite: Mn.Sc. 411, Unit B. *Messrs. Bates and Comer*
540. SOLID STATE STRUCTURES AND REACTIONS IN MINERAL SYSTEMS (2-4) Crystal chemical approach to solid state reactions, sintering, melting, hardness, thermal expansion, and behavior of matter under high pressure. *Mr. Weyl*

## NATURE EDUCATION (NA ED)

401. TRAINING IN NATURE FOR CAMP COUNSELORS (3)

## RELIGIOUS STUDIES (RL ST)

- \*400. RELIGIOUS IDEAS OF GREAT MEN (1)  
 401. RELIGIOUS PHILOSOPHY OF THE GREAT REFORMERS (3)  
 402. CONTEMPORARY RELIGIOUS THOUGHT (3)  
 410. BIBLICAL STUDIES: OLD TESTAMENT (3)  
 420. BIBLICAL STUDIES: NEW TESTAMENT (3)  
 430. RELIGION AND MORALITY (3)

## RUSSIAN (RUS)

426. DOSTOEVSKY (3)  
 427. TOLSTOY (3)  
 450. HISTORY OF THE RUSSIAN LANGUAGE (3)  
 460. LINGUISTIC ANALYSIS OF CONTEMPORARY RUSSIAN (3)
- †1G. TECHNICAL RUSSIAN FOR GRADUATE STUDENTS (3) Prepares student to translate technical and scientific texts. No previous knowledge of Russian is required.
501. READINGS IN RUSSIAN LITERATURE (3-6) Prerequisite: Rus. 4.
525. PUSHKIN (3) Pushkin's significance in Russian literature; his relation to other European literatures; *Eugene Onegin* and selected shorter works.
542. SEMINAR IN SOVIET LITERATURE (3-6) Works of representative Soviet writers; individual research in contemporary Soviet literature and literary criticism.

## SLAVIC (SLAV)

550. OLD CHURCH SLAVIC (3) Reading and study of that corpus of religious and liturgical documents representing the first written records of a Slavic tongue.

\*May be repeated for a maximum of 3 credits.

†No graduate credit is given for this course.



## SLAVIC

560. THEORY AND TECHNIQUE IN SLAVIC LINGUISTICS (3-6) Analysis of the relationship of the Slavic languages; consideration of particular linguistic problems within one or more of the languages.

## VETERINARY SCIENCE (V SC)

400. VETERINARY ANATOMY AND PHYSIOLOGY (3)  
401. INFECTIOUS DISEASES OF DOMESTIC ANIMALS (3)  
515. (Bact. 515) VIROLOGY (2-4) Rickettsial and viral agents parasitizing man, animals, and microorganisms. Prerequisite: Bact. 410.

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1963-1964

# THE PENNSYLVANIA STATE UNIVERSITY BULLETIN

GRADUATE DEGREE PROGRAMS

GENERAL CATALOG ISSUE • FEBRUARY 1963



## OFFICE OF THE GRADUATE SCHOOL

101 Willard Building  
University Park, Pennsylvania

Telephone: Area Code 814, UN 5-6323

**NOTICE:** The University operates throughout the year on a four-term basis. The fall, winter, spring, and summer terms consist of 10 weeks each.

**LOCATION:** The post office address of The Pennsylvania State University is University Park, Pennsylvania, but the town in which the University is located is State College.

## THE PENNSYLVANIA STATE UNIVERSITY BULLETIN

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UNIVERSITY PARK, PENNSYLVANIA

**1963-1964**  
**THE PENNSYLVANIA STATE**  
**UNIVERSITY**

**GRADUATE DEGREE PROGRAMS**

**GENERAL CATALOG ISSUE • FEBRUARY 1963**

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# \*GRADUATE CALENDAR

## WINTER TERM 1963

NOTE: *November 3, 1962, was the last date to apply for permission to resume graduate study in the Winter Term 1963.*

### JANUARY 1963

- 3-5 Thursday Noon to Saturday Noon—Winter Term Registration
- 3-5 Thursday to Saturday—Oral Examination in Foreign Languages for Advanced Degree Candidates
- 7 Monday—Winter Term Classes Begin 8 a.m.
- 7 Monday—Last Date for Registering with Foreign Language Departments for Written Language Examinations
- 15 Tuesday—Graduate Faculty Meeting
- 16 Wednesday—Last Date for Adding Courses to Approved Schedules
- 21 Monday—Last Date for Paying Thesis Fees and for Informing Recorder of Intention to Graduate in March
- 28 Monday—Written Foreign Language Examinations for Advanced Degree Candidates

### FEBRUARY

- 19 Tuesday—Graduate Faculty Meeting
- 23 Saturday—Last Date for a March Graduate to Deliver Doctoral Thesis to Committee

### MARCH

- 2 Saturday—Last Date for Final Oral Doctoral Examination for March Graduates
- 2 Saturday—Last Date for a March Graduate to Deliver Master's Thesis to Adviser
- 2 Saturday—Last Date for a March Graduate to Rent Cap, Gown, and Hood Locally
- 9 Saturday—Theses Due in Graduate School Office 12 Noon
- 9 Saturday—Last Date for Submitting a Petition to Graduate in Absentia in March
- 16 Saturday—Winter Term Classes End 12:25 p.m.
- 18-20 Monday to Wednesday—Final Examinations
- 23 Saturday—Commencement

## SPRING TERM 1963

NOTE: *January 26, 1963, is the last date to apply for permission to resume graduate study in the Spring Term 1963.*

### MARCH 1963

- 26-27 Tuesday and Wednesday—Spring Term Registration
- 26-27 Tuesday and Wednesday—Oral Examination in Foreign Languages for Advanced Degree Candidates

\*This calendar was approved July 28, 1962. It is subject to change without notice.

- 28 Thursday—Spring Term Classes Begin 8 a.m.
- 28 Thursday—Last Date for Registering with Foreign Language Department for Written Language Examinations

#### APRIL

- 6 Saturday—Last Date for Adding Courses to Approved Schedules
- 15 Monday—Last Date for Paying Thesis Fees and for Informing Records of Intention to Graduate in June
- 16 Tuesday—Graduate Faculty Meeting
- 22 Monday—Written Foreign Language Examinations for Advanced Degree Candidates

#### MAY

- 11 Saturday—Last Date for a June Graduate to Deliver Doctoral Thesis Committee
- 18 Saturday—Last Date for Final Oral Doctoral Examination for June Graduates
- 18 Saturday—Last Date for a June Graduate to Deliver Master's Thesis to Adviser
- 18 Saturday—Last Date for a June Graduate to Rent Cap, Gown, and Hood Locally
- 21 Tuesday—Graduate Faculty Meeting
- 25 Saturday—Theses Due in Graduate School Office 12 Noon
- 25 Saturday—Last Date for Submitting a Petition to Graduate in Absentia in June

#### JUNE

- 5 Wednesday—Spring Term Classes End 9:55 p.m.
- 6-8 Thursday to Saturday—Final Examinations
- 9 Sunday—Commencement

### SUMMER TERM 1963

NOTE: *April 18, 1963, is the last date to apply for permission to resume graduate study in the Summer Term 1963.*

#### JUNE 1963

- 18 Tuesday—Summer Term Registration
- 18 Tuesday—Oral Examination in Foreign Languages for Advanced Degree Candidates
- 19 Wednesday—Summer Term Classes Begin 8 a.m.
- 19 Wednesday—Last Date for Registering with Foreign Language Departments for Written Language Examinations
- 28 Friday—Last Date for Adding Courses to Approved Schedules

#### JULY

- †4 Thursday—Independence Day
- 8 Monday—Last Date for Paying Thesis Fees and for Informing Records of Intention to Graduate in September

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†Classes which would have met on Thursday, July 4, will meet according to schedule on Wednesday, August 28, 1963.

- 15 Monday—Written Foreign Language Examination for Advanced Degree Candidates
- 16 Tuesday—Graduate Faculty Meeting

## AUGUST

- 3 Saturday—Last Date for a September Graduate to Deliver Doctoral Thesis to Committee
- 10 Saturday—Last Date for Final Oral Doctoral Examination for September Graduates
- 10 Saturday—Last Date for a September Graduate to Deliver Master's Thesis to Adviser
- 10 Saturday—Last Date for a September Graduate to Rent Cap, Gown, and Hood Locally
- 17 Saturday—Theses Due in Graduate School Office 12 Noon
- 17 Saturday—Last Date for Submitting a Petition to Graduate in Absentia in September
- 20 Tuesday—Graduate Faculty Meeting
- 28 Wednesday—Summer Term Classes End 9:55 p.m.
- 29-31 Thursday to Saturday—Final Examinations

## SEPTEMBER

- 1 Sunday—Commencement

## FALL TERM 1963

NOTE: *July 25, 1963, is the last date to apply for permission to resume graduate study in the Fall Term 1963.*

## SEPTEMBER 1963

- 25-28 Wednesday to Saturday Noon—Fall Term Registration
- 25-28 Wednesday to Saturday—Oral Examination in Foreign Languages for Advanced Degree Candidates
- 30 Monday—Fall Term Classes Begin 8 a.m.
- 30 Monday—Last Date for Registering with Foreign Language Departments for Written Language Examinations

## OCTOBER

- 9 Wednesday—Last Date for Adding Courses to Approved Schedules
- 14 Monday—Last Date for Paying Thesis Fees and for Informing Recorder of Intention to Graduate in December
- 15 Tuesday—Graduate Faculty Meeting
- 21 Monday—Written Foreign Language Examinations for Advanced Degree Candidates

## NOVEMBER

- 16 Saturday—Last Date for a December Graduate to Deliver Doctoral Thesis to Committee
- 19 Tuesday—Graduate Faculty Meeting
- 23 Saturday—Last Date for Final Oral Doctoral Examination for December Graduates



- 23 Saturday—Last Date for a December Graduate to Deliver Master's Thesis to Adviser
- 23 Saturday—Last Date for a December Graduate to Rent Cap, Gown, and Hood Locally
- ‡28 Thursday—Thanksgiving Day
- 30 Saturday—Theses Due in Graduate School Office 12 Noon
- 30 Saturday—Last Date for Submitting a Petition to Graduate in Absentia in December

## DECEMBER

- 9 Monday—Fall Term Classes End 9:55 p.m.
- 10-12 Tuesday to Thursday—Final Examinations
- 14 Saturday—Commencement

## WINTER TERM 1964

NOTE: *November 7, 1963, is the last date to apply for permission to resume graduate study in the Winter Term 1964.*

## JANUARY 1964

- 7-8 Tuesday and Wednesday—Winter Term Registration
- 7-8 Tuesday and Wednesday—Oral Examination in Foreign Languages for Advanced Degree Candidates
- 9 Thursday—Winter Term Classes Begin 8 a.m.
- 9 Thursday—Last Date for Registering with Foreign Language Department for Written Language Examination
- 18 Saturday—Last Date for Adding Courses to Approved Schedules
- 21 Tuesday—Graduate Faculty Meeting
- 27 Monday—Last Date for Paying Thesis Fees and for Informing Recorder of Intention to Graduate in March

## FEBRUARY

- 3 Monday—Written Foreign Language Examination for Advanced Degree Candidates
- 18 Tuesday—Graduate Faculty Meeting
- 22 Saturday—Last Date for a March Graduate to Deliver Doctoral Thesis to Committee
- 29 Saturday—Last Date for Final Oral Doctoral Examination for March Graduates
- 29 Saturday—Last Date for a March Graduate to Deliver Master's Thesis to Adviser
- 29 Saturday—Last Date for a March Graduate to Rent Cap, Gown, and Hood Locally

## MARCH

- 7 Saturday—Theses Due in Graduate School Office 12 Noon
- 7 Saturday—Last Date for Submitting a Petition to Graduate in Absentia in March
- 18 Wednesday—Winter Term Classes End 9:55 p.m.
- 19-21 Thursday to Saturday—Final Examinations
- 22 Sunday—Commencement

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‡Classes which would have met on Thursday, November 28, will meet according to schedule on Monday, December 9, 1963.

## SPRING TERM 1964

NOTE: *January 31, 1964, is the last date to apply for permission to resume graduate study in the Spring Term 1964.*

### MARCH 1964

- 31 Tuesday—Spring Term Registration
- 31 Tuesday—Oral Examination in Foreign Languages for Advanced Degree Candidates

### APRIL

- 1 Wednesday—Spring Term Registration
- 1 Wednesday—Oral Examination in Foreign Languages for Advanced Degree Candidates
- 2 Thursday—Spring Term Classes Begin 8 a.m.
- 2 Thursday—Last Date for Registering with Foreign Language Departments for Written Language Examinations
- 11 Saturday—Last Date for Adding Courses to Approved Schedules
- 20 Monday—Last Date for Paying Thesis Fees and for Informing Recorder of Intention to Graduate in June
- 21 Tuesday—Graduate Faculty Meeting
- 27 Monday—Written Foreign Language Examination for Advanced Degree Candidates

### MAY

- 16 Saturday—Last Date for a June Graduate to Deliver Doctoral Thesis to Committee
- 19 Tuesday—Graduate Faculty Meeting
- 23 Saturday—Last Date for Final Oral Doctoral Examination for June Graduates
- 23 Saturday—Last Date for a June Graduate to Deliver Master's Thesis to Adviser
- 23 Saturday—Last Date for a June Graduate to Rent Cap, Gown, and Hood Locally
- 30 Saturday—Theses Due in Graduate School Office 12 Noon
- 30 Saturday—Last Date for Submitting a Petition to Graduate in Absentia in June

### JUNE

- 10 Wednesday—Spring Term Classes End 9:55 p.m.
- 11-13 Thursday to Saturday—Final Examinations
- 14 Sunday—Commencement

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RAYMOND G. D. AYOUB, Ph.D. (Illinois)	Professor of Mathematics
RUTH W. AYRES, Ph.D. (Brookings)	Professor of Clothing and Textiles
FRANCIS A. BABIONE, Ph.D. (Ohio State)	Associate Professor of Marketing
PAUL T. BAKER, Ph.D. (Harvard)	Assistant Professor of Anthropology
BRUCE H. BARNES, Ph.D. (Michigan State)	Assistant Professor of Mathematics
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WILLIAM L. BARR, Ph.D. (Cornell)	Professor of Farm Management
GEORGE P. BARRON, JR., Ph.D. (Penn State)	Professor of Animal Nutrition
HOWARD D. BARTLETT, M.S. (Maine), P.E.	Assoc. Prof. of Agricultural Eng.
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THOMAS F. BATES, Ph.D. (Columbia)	Professor of Mineralogy
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R. WALLACE BREWSTER, Ph.D. (California)	Professor of Political Science
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IRA V. BROWN, Ph.D. (Harvard)	<i>Professor of American History</i>
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DAVID E. DAVIS, Ph.D. (Harvard)	<i>Professor of Zoology</i>
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JAMES W. DUNLOP, M.Mus. (Michigan)	<i>Professor of Music Education</i>
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PAUL EBAUGH, A.B. (Denison)	<i>Professor of Engineering Research</i>
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PAUL EDMONSTON, Ph.D. (Ohio State)	<i>Assistant Professor of Art Education</i>
ROBERT ENCGASS, Ph.D. (Michigan)	<i>Assoc. Prof. of Hist. of Art and Arch.</i>
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JOHN H. FERGUSON, Ph.D. (Pennsylvania)	<i>Prof. of Pol. Sci. and Pub. Adm.</i>
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ILINE FIFE, Ph.D. (Louisiana State)	<i>Associate Professor of Speech</i>
HENRY A. FINCH, Ph.D. (Pennsylvania)	<i>Professor of Philosophy</i>
HUMMEL FISHBURN, Mus.D. (Montreal)	<i>Prof. of Music and Music Ed.</i>
GEORGE H. FLEMING, Ph.D. (Penn State)	<i>Professor of Chemistry</i>
HAROLD K. FLEMING, M.S. (Penn State)	<i>Professor of Pomology</i>
PETER W. FLETCHER, Ph.D. (Missouri)	<i>Professor of Forestry</i>
FREDERICK C. FLIEGEL, Ph.D. (Wisconsin)	<i>Asst. Prof. of Rural Sociology</i>
ROBERT J. FLIPSE, Ph.D. (Michigan State)	<i>Assoc. Prof. of Dairy Science</i>
ANTHONY H. FODERARO, Ph.D. (Pittsburgh)	<i>Assoc. Prof. of Nuclear Engineering</i>
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KENT FORSTER, Ph.D. (Pennsylvania)	<i>Professor of European History</i>
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ROBERT F. GENTRY, Ph.D. (Michigan State)	<i>Professor of Veterinary Science</i>
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WILLIAM M. HENCH, Ph.D. (Pennsylvania)	Professor of Economics
GRACE M. HENDERSON, Ph.D. (Ohio State)	Professor of Home Economics
WILLIAM L. HENNING, Ph.D. (Wisconsin)	Professor of Animal Industry
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CHARLES L. HOSLER, JR., Ph.D. (Penn State)	Professor of Meteorology
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HAROLD K. SCHILLING, Ph.D. (Iowa), D.Sc.	<i>Professor of Physics</i>
ROBERT F. SCHMALZ, Ph.D. (Harvard)	<i>Assistant Professor of Geology</i>
ERWIN R. SCHMERLING, Ph.D. (Cambridge)	<i>Assoc. Prof. of Electrical Eng.</i>
FRANK W. SCHMIDT, Ph.D. (Wisconsin)	<i>Asst. Prof. of Mechanical Eng.</i>
C. DAVID SCHMULBACH, Ph.D. (Illinois)	<i>Assistant Professor of Chemistry</i>
LOWELL SCHOENFELD, Ph.D. (Pennsylvania)	<i>Professor of Mathematics</i>
ROBERT SCHOLTEN, Ph.D. (Michigan)	<i>Assoc. Prof. of Petroleum Geology</i>
WILLIAM J. SCHRADER, D.B.A. (Washington), C.P.A.	<i>Professor of Accounting</i>
HARALD SCHRAER, Ph.D. (Cornell)	<i>Associate Professor of Biophysics</i>
ROSEMARY SCHRAER, Ph.D. (Syracuse)	<i>Assistant Professor of Biophysics</i>
CLAYTON H. SCHUG, M.A. (Ohio State)	<i>Professor of Speech</i>
RALPH P. SEWARD, Ph.D. (Brown)	<i>Professor of Chemistry</i>
MAURICE SHAMMA, Ph.D. (Wisconsin)	<i>Associate Professor of Chemistry</i>
M. G. SHARMA, Ph.D. (Penn State)	<i>Asst. Prof. of Engineering Mechanics</i>
WARD M. SHARP, Ph.D. (Washington U.)	<i>Professor of Wildlife Management</i>
ISADOR M. SHEFFER, Ph.D. (Harvard)	<i>Professor of Mathematics</i>
PHILIP A. SHELLEY, Ph.D. (Harvard)	<i>Prof. of German and Comparative Lit.</i>
PAUL E. SHIELDS, M.S. (Pittsburgh), E.E., P.E.	<i>Assoc. Prof. of Elec. Eng.</i>
JAMES W. SHIGLEY, Ph.D. (Penn State)	<i>Assoc. Prof. of Agr. and Biol. Chem.</i>
BRUCE R. SHOBAKEN, M.F.A. (Minnesota)	<i>Assistant Professor of Art</i>
SAMUEL SHULITS, M.S. (Michigan Col. Mining and Tech.)	<i>Prof. of Civil Eng.</i>
ALBERTA E. SIEGEL, Ph.D. (Stanford)	<i>Professor of Child Development</i>
BRUCE M. SIEGENTHALER, Ph.D. (Michigan)	<i>Prof. of Clin. Speech and Audiology</i>
PETER S. SIGNELL, Ph.D. (Rochester)	<i>Associate Professor of Physics</i>
RUTH C. SILVA, Ph.D. (Michigan)	<i>Professor of Political Science</i>
PAUL D. SIMKINS, Ph.D. (Wisconsin)	<i>Assistant Professor of Geography</i>
PHILIP S. SKELL, Ph.D. (Duke)	<i>Professor of Chemistry</i>
EUGEN SKUDRZYK, Ph.D. (Berlin)	<i>Professor of Engineering Research</i>
ROBERT L. SLOBOD, Ph.D. (Northwestern)	<i>Prof. of Petroleum and Natural Gas Eng.</i>
CYRIL B. SMITH, Ph.D. (Penn State)	<i>Associate Professor of Plant Nutrition</i>
GORDON R. SMITH, Ph.D. (Penn State)	<i>Associate Professor of English</i>
GRANT W. SMITH, Ph.D. (Minnesota)	<i>Professor of Chemistry</i>
HERBERT A. SMITH, Ph.D. (Nebraska)	<i>Professor of Education</i>
KINSLEY R. SMITH, Ph.D. (Pennsylvania)	<i>Professor of Psychology</i>
WARREN S. SMITH, M.A. (Iowa)	<i>Professor of Theatre Arts</i>
WILLIAM M. SMITH, JR., Ph.D. (Cornell)	<i>Professor of Family Relationships</i>
THOMAS SMYTH, JR., Ph.D. (Johns Hopkins)	<i>Asst. Professor of Entomology</i>
ROBERT J. SNETSINGER, Ph.D. (Illinois)	<i>Assistant Professor of Entomology</i>
JOHN C. SNOWDON, Ph.D. (London), D.I.C.	<i>Asst. Prof. of Engineering Research</i>
HELEN I. SNYDER, Ph.D. (Illinois)	<i>Assistant Professor of Psychology</i>
J. ROBERT SNYDER, Ph.D. (Pennsylvania), P.E.	<i>Assoc. Prof. of Chemical Eng.</i>
LEO H. SOMMER, Ph.D. (Penn State)	<i>Professor of Chemistry</i>

## GRADUATE FACULTY

WILLIAM E. SOPPER, Ph.D. (Yale)	Assistant Professor of Forestry
HERMAN M. SOUTHWORTH, A.B. (Cornell)	Prof. of Agricultural Economics
WILLIAM SPACKMAN, JR., Ph.D. (Harvard)	Professor of Paleobotany
CHARLES M. SPEIDEL, M.S. (Penn State)	Professor of Physical Education
THEODORE S. SPICER, Fuels E. (Penn State), P.E.	Prof. of Min. Prep. Eng.
HOWARD B. SPRAGUE, Ph.D. (Rutgers)	Professor of Agronomy
VANCE G. SPRAGUE, Ph.D. (Wisconsin), D.Sc.	Professor of Agronomy
C. DREW STAHL, Ph.D. (Penn State)	Prof. of Petroleum and Natural Gas Eng.
JAMES L. STARLING, Ph.D. (Penn State)	Assistant Professor of Agronomy
WILLIAM A. STEELE, Ph.D. (Washington)	Associate Professor of Chemistry
ROBERT STEFANKO, Ph.D. (Penn State)	Asst. Prof. of Mining Engineering
F. BRISCOE STEPHENS, Ph.D. (Penn State)	Assoc. Professor of Meteorology
GLENN Z. STEVENS, Ph.D. (Minnesota)	Professor of Agricultural Education
HARLAN STEVENS, Ph.D. (Duke)	Assistant Professor of Mathematics
ROBERT W. STONE, Ph.D. (Iowa State)	Professor of Bacteriology
RICHARD G. STONER, Ph.D. (Princeton)	Professor of Physics
RANDALL S. STOUT, Ph.D. (Pittsburgh)	Professor of Economics
WERNER F. STRIEDIECK, Ph.D. (Michigan)	Associate Professor of German
EARL P. STRONG, Ed.D. (N.Y.U.)	Professor of Management
GREENVILLE K. STROTHER, Ph.D. (Penn State)	Asst. Professor of Physics
VLADIMIR STUBICAN, Dr.Phil., D.Sc. (U. Zagreb)	Assoc. Prof. Solid State Tech.
H. TRACY STURCKEN, Ph.D. (North Carolina)	Assoc. Prof. of Romance Languages
JOSEPH T. SULLIVAN, Ph.D. (Purdue)	Professor of Phytochemistry
SHIOU-CHUAN SUN, Sc.D. (M.I.T.)	Professor of Mineral Preparation
M. RICHARD SUSSMAN, Ph.D. (Michigan)	Associate Professor of Finance
A. BRUCE SUTHERLAND, Ph.D. (Pennsylvania)	Professor of English Literature
FRANK M. SWARTZ, Ph.D. (Johns Hopkins)	Research Prof. of Paleontology
ROBERT W. TAFT, JR., Ph.D. (Ohio State)	Professor of Chemistry
JAMES TAMMEN, Ph.D. (California)	Associate Professor of Plant Pathology
HAROLD I. TARPLEY, M.S. (Illinois), P.E.	Professor of Electrical Engineering
WILLA C. TAYLOR, M.A. (N.Y.U.)	Professor of Music
EDWARD C. THADEN, D.U.P. (Paris)	Assoc. Professor of European History
GEORGE A. THEODORSON, Ph.D. (Cornell)	Associate Professor of Sociology
DENO G. THEVAOS, Ed.D. (Columbia)	Associate Professor of Psychology
GLENN N. THIEL, M.Ed. (Penn State)	Professor of Physical Education
WALTER I. THOMAS, Ph.D. (Iowa State)	Associate Professor of Agronomy
S. EARL THOMPSON, D.Ed. (Illinois)	Prof. of Hotel and Institution Adm.
GEORGE L. THUERING, M.S. (Penn State), M.E., P.E.	Prof. of Industrial Eng.
CLARENCE E. THURBER, Ph.D. (Stanford)	Assoc. Prof. Pol. Sci. and Pub. Adm.
THOMAS T. THWAITES, Ph.D. (Rochester)	Assistant Professor of Physics
GERALD M. TORKELSON, D.Ed. (Penn State)	Professor of Education
HOWARD O. TRIEBOLD, Ph.D. (Minnesota)	Prof. of Agr. and Biol. Chem.
ALFRED A. TRIOLO, Ph.D. (Illinois)	Asst. Professor of Romance Languages
CLARENCE E. TROTTER, Ph.D. (Minnesota)	Professor of Marketing
GEORGE TSOUNMIS, D.For. (Yale)	Assistant Professor of Wood Technology
ALBERT G. TSUGAWA, Ph.D. (Michigan)	Asst. Professor of Philosophy
LOREN D. TUKEY, Ph.D. (Ohio State)	Associate Professor of Pomology
O. FRANK TUTTLE, Ph.D. (M.I.T.)	Professor of Geochemistry
WARREN N. UNDERWOOD, C.E. (Princeton), P.E.	Assoc. Prof. of Civil Engineering
HUGH B. URBAN, Ph.D. (Penn State)	Assistant Professor of Psychology
VLADIMIR VAND, D.Sc. (Glasgow)	Professor of Crystallography
ABRAM W. VANDERMEER, Ph.D. (Chicago)	Professor of Education
EDWARD B. VANORMER, Ph.D. (Columbia)	Professor of Psychology
FRANCIS J. VASTOLA, Ph.D. (Penn State)	Asst. Prof. of Fuel Technology
JEANNETTE VEATCH, Ph.D. (N.Y.U.)	Associate Professor of Education
DOROTHY H. VEON, Ed.D. (Columbia)	Professor of Education
ROBERT K. VIERCK, M.S. (Iowa), P.E.	Professor of Engineering Mechanics



## GRADUATE FACULTY

CARL VOLZ, Ph.D. (Penn State)	<i>Professor of Electrical Engineering</i>
BURTON E. VOSS, Ph.D. (Iowa)	<i>Assistant Professor of Education</i>
JAMES B. WADSWORTH, Ph.D. (Harvard)	<i>Assoc. Prof. of Romance Languages</i>
HERBERT A. WAHL, Ph.D. (Penn State)	<i>Professor of Botany</i>
DARRELL E. WALKER, Ph.D. (California)	<i>Assoc. Professor of Plant Breeding</i>
PHILIP L. WALKER, JR., Ph.D., (Penn State)	<i>Professor of Fuel Technology</i>
WALTER H. WALTERS, Ph.D. (Western Reserve)	<i>Professor of Theatre Arts</i>
WILBER W. WARD, D.For. (Yale)	<i>Associate Professor of Forestry</i>
JOHN M. WARREN, Ph.D. (Wisconsin)	<i>Assoc. Professor of Psychology</i>
THOMAS WARTIK, Ph.D. (Chicago)	<i>Professor of Chemistry</i>
JOHN B. WASHKO, Ph.D. (Wisconsin)	<i>Professor of Agronomy</i>
R. HADLY WATERS, Ph.D. (Pennsylvania)	<i>Professor of Transportation</i>
GEORGE H. WATROUS, JR., Ph.D. (Penn State)	<i>Assoc. Prof. of Dairy Mfg.</i>
ARTHUR H. WAYNICK, Sc.D. (Harvard)	<i>Professor of Electrical Engineering</i>
WAYNE WEBB, Ph.D. (Iowa)	<i>Professor of Physics</i>
JON N. WEBER, Ph.D. (Toronto)	<i>Research Associate in Geochemistry</i>
ROBERT L. WEBER, Ph.D. (Penn State)	<i>Associate Professor of Physics</i>
STANLEY WEINTRAUB, Ph.D. (Penn State)	<i>Associate Professor of English</i>
WINSTON R. WEISMAN, Ph.D. (Ohio State)	<i>Prof. of Hist. of Art and Arch.</i>
ARTHUR M. WELLINGTON, M.A. (Ohio State)	<i>Prof. of Counselor Education</i>
CLIFFORD C. WERNHAM, Ph.D. (Cornell)	<i>Professor of Plant Pathology</i>
DAVID L. WESTBY, Ph.D. (Michigan State)	<i>Assistant Professor of Sociology</i>
WOLDEMAR WEYL, Dr.Ing. (Aachen)	<i>Evan Pugh Res. Prof. of Phys. Sci.</i>
FRANCIS L. WHALEY, Ph.D. (Michigan)	<i>Associate Professor of Psychology</i>
RALPH H. WHERRY, M.A. (Penn State), C.L.U.	<i>Professor of Insurance</i>
BENJAMIN A. WHISLER, Sc.D. (Harvard), P.E.	<i>Professor of Civil Engineering</i>
EUGENE E. WHITE, Ph.D. (Louisiana State)	<i>Associate Professor of Speech</i>
WALLACE E. WHITE, Ph.D. (Yale)	<i>Professor of Wood Technology</i>
DELPHA E. WIESENDANGER, M.S. (Cornell)	<i>Prof. of Home Mgmt. and Housing</i>
THOMAS A. WIGGINS, Ph.D. (Penn State)	<i>Associate Professor of Physics</i>
MELVIN A. WILKOV, Ph.D. (Penn State)	<i>Asst. Prof. of Eng. Mechanics</i>
MARY L. WILLARD, Ph.D. (Cornell)	<i>Professor of Chemistry</i>
ARTHUR L. WILLIAMS, Ph.D. (Pennsylvania), C.L.U.	<i>Asst. Prof. of Insurance</i>
EUGENE G. WILLIAMS, Ph.D. (Penn State)	<i>Associate Professor of Geology</i>
WILLIAM A. WILLIAMS, Ed.D. (Pittsburgh)	<i>Professor of Industrial Education</i>
MERRITT A. WILLIAMSON, Ph.D. (Yale), P.E.	<i>Professor of Engineering</i>
WILLIAM O. WILLIAMSON, Ph.D., D.Sc. (London)	<i>Assoc. Prof. of Cer. Tech.</i>
DONALD J. WILLOWER, Ed.D. (Buffalo)	<i>Associate Professor of Education</i>
CLYDE J. WINGFIELD, D.P.A. (Syracuse)	<i>Asst. Prof. of Pol. Sci. and Pub. Adm.</i>
ROLF C. WINTER, D.Sc. (Carnegie Tech.)	<i>Associate Professor of Physics</i>
GEORGE F. WISLICENUS, Ph.D. (California Tech.), P.E.	<i>Prof. of Aero. Eng.</i>
FRANCIS A. WOOD, Ph.D. (Minnesota)	<i>Asst. Professor of Forest Pathology</i>
MERRILL WOOD, M.S. (Penn State)	<i>Assoc. Professor of Zoology</i>
ARTHUR E. WOODWARD, Ph.D. (Brooklyn Polytech.)	<i>Assoc. Professor of Physics</i>
RICHARD N. WORK, Ph.D. (Cornell)	<i>Assoc. Professor of Physics</i>
HAROLD D. WRIGHT, Ph.D. (Columbia)	<i>Assoc. Professor of Mineralogy</i>
JAMES E. WRIGHT, JR., Ph.D. (Cornell)	<i>Professor of Genetics</i>
LAUREN A. WRIGHT, Ph.D. (California Tech.)	<i>Professor of Geology</i>
PETER J. WYLLIE, Ph.D. (St. Andrews)	<i>Associate Professor of Petrology</i>
KELLY YEATON, M.A. (Washington)	<i>Assoc. Professor of Theatre Arts</i>
PHILIP YOUNG, Ph.D. (Iowa)	<i>Professor of American Literature</i>
JOSEPH ZAFFORONI, Ed.D. (Columbia)	<i>Associate Professor of Education</i>
MARTIN L. ZEIGLER, Ph.D. (Penn State)	<i>Research Assoc. in Psychology</i>
HAROLD P. ZELKO, M.A. (Ohio State), LL.B.	<i>Professor of Speech</i>
LEONARD N. ZIMMERMAN, Ph.D. (Cornell)	<i>Assoc. Professor of Bacteriology</i>
HARRY D. ZOOK, Ph.D. (Penn State)	<i>Professor of Chemistry</i>
GEORGE S. ZORETICH, M.A. (Penn State)	<i>Professor of Art</i>



## GRADUATE FACULTY

### LECTURERS

ARNOLD ADDISON, M.A. (West Virginia)	<i>Assoc. Prof. of Eng. Research</i>
CHARLES D. AUVENSHINE, M.Ed. (Missouri)	<i>Instructor in Education</i>
DALE E. BAKER, Ph.D. (Missouri)	<i>Asst. Prof. of Soil Technology</i>
LELAND L. BEIK, Ph.D. (Columbia)	<i>Associate Professor of Marketing</i>
CLARENCE O. BERGESON, Ed.D. (Columbia)	<i>Associate Professor of Education</i>
AARON DRUCKMAN, B.A. (Penn State)	<i>Associate Professor of Philosophy</i>
ALFRED J. ENGEL, Ph.D. (Wisconsin)	<i>Asst. Prof. of Chemical Engineering</i>
ERVIN P. HEXNER, Dr.Pol.Sci., D.J.S.	<i>Dist. Visiting Prof. Bus. Ad. and Econ.</i>
BARTON L. JENKS, JR., M.S. (Princeton)	<i>Assoc. Prof. of Mechanical Engineering</i>
OSCAR A. KIMMEL, M.S. (Penn State)	<i>Assistant Professor of Farm Mechanics</i>
DANIEL R. LEASURE, D.Ed. (Penn State)	<i>Instructor in Education</i>
J. CAMPBELL LESTER, M.S. (Penn State), P.E.	<i>Assoc. Prof. of Mechanical Eng.</i>
NELL A. MURPHY, D.Ed. (Stanford)	<i>Associate Professor of Education</i>
VINCENT P. NORRIS, Ph.D. (Illinois)	<i>Assistant Professor of Advertising</i>
MICHAEL POREH, Ph.D. (Colorado State)	<i>Visiting Asst. Prof. of Aero. Eng.</i>
JOHN M. SHEMICK, M.A. (Michigan State)	<i>Assoc. Prof. of Industrial Arts Ed.</i>
ARTHUR T. THOMPSON, S.M. (Harvard)	<i>Professor of Engineering</i>
WILLIAM J. TISDALL, Ph.D. (Illinois)	<i>Assistant Professor of Education</i>
WALTER F. WESTERFELD, M.S. (Penn State)	<i>Assistant Professor of Botany</i>
DUANE H. WHITTIER, Ph.D. (Illinois)	<i>Instructor in Philosophy</i>

# GENERAL INFORMATION

**G**RADUATE WORK at The Pennsylvania State University was first offered in 1862 when two graduate students were in residence. It was given more formal recognition in 1864 by the establishment of a "course for Graduates" designed for students who, after receiving the degree of Bachelor of Scientific Agriculture, wished to do advanced work leading to the degree of Master of Scientific Agriculture. For some time there were few graduate students, and graduate instruction was relatively unorganized. Later a committee of the University Senate was given the responsibility of establishing standards and regulations governing graduate work and the granting of advanced degrees. The Graduate School was organized in 1922. Until this time only masters' degrees and certain technical degrees had been conferred. In 1924 the Board of Trustees authorized the granting of the degree of Doctor of Philosophy. Still later other degrees were approved.

The faculty of the Graduate School consists of the President and certain other general administrative officers of the University, the Deans, the Librarian, the heads of departments, and those members of the instructional staff who have been authorized by the proper agencies of the Graduate School to offer graduate courses and supervise research leading to theses. It controls all academic matters pertaining to the Graduate School, subject to review by the University Senate.

The Graduate Faculty has approximately 750 members. Graduate student enrollment was about 2,500 per term for the four terms of 1961-62. The number of advanced degrees conferred in 1961-62 was 930, of which 157 were doctorates.

**COOPERATIVE ARRANGEMENTS WITH OTHER INSTITUTIONS**—A working arrangement has been established with Jefferson Medical College of Philadelphia whereby a candidate for an advanced degree at Jefferson may do part of his graduate work at Penn State by scheduling relevant courses and research at University Park. Similarly a graduate student with an appropriate major at Penn State may earn credits at Jefferson which, upon advance approval by his major department, will be accepted in partial fulfillment of degree requirements at Penn State.

## PROCEDURES AND REGULATIONS

A student is expected to assume full responsibility for knowing the regulations and pertinent procedures of the Graduate School as set forth in this publication, the *Manual for Graduate Students*, and the *Thesis Information Bulletin*, and for meeting the standards and requirements expressed by these regulations. The *Manual*, which is available to a student after he has been admitted, sets forth in more detail the procedures governing registration, changes in program, and graduation, and gives other information about the Graduate School which is useful to graduate students. Every student should secure a copy from the Dean's office soon after admission.

## ADMISSION

An applicant for admission to the Graduate School should understand that graduate work is not simply an extension of undergraduate work. It operates at a definitely higher level, demands scholarship of a high order, and emphasizes research and creativity. It involves a minimum of formal requirements and regulations, and a maximum of student initiative and responsibility.

A student does not become a graduate student merely by enrolling for advanced courses after having received a baccalaureate degree. Formal admission to the Graduate School is required. Credits earned before admission cannot be applied to meet degree requirements at a later date even though admission may have been granted in the meantime.



## ADMISSION

Admission is granted by the Dean of the Graduate School after approval of the application by the department in which the student plans to do his major work. Blanks to be used in making formal application for admission can be obtained from the Graduate School office. In general, a student may begin his graduate work in fall, winter, spring, or summer. Prospective students may write directly to the head of any department concerning graduate work in that specific field.

Students from other countries are encouraged to write to the Director of International Student Affairs for information concerning finances, housing, and other non-academic matters.

**CREDENTIALS**—An applicant for admission should provide complete credentials, in duplicate, sent directly from other institutions to the Dean of the Graduate School at least six weeks prior to the opening of the term in which he plans to begin his graduate program. If the applicant has attended more than one institution, two official transcripts of the work covered at each institution are required. This applies to the complete academic record, both undergraduate and graduate.

A student with a slight deficiency in undergraduate preparation may be admitted and allowed to take a limited number of undergraduate courses to make up the deficiency while proceeding with his graduate program. Courses taken for this purpose do not, of course, apply toward the requirements for an advanced degree.

**UNQUALIFIED ADMISSION**—For unqualified admission to the Graduate School an applicant must have received a baccalaureate degree from an accredited institution, earned under residence and credit conditions substantially equivalent to those required by The Pennsylvania State University. He must have maintained during his junior and senior years a minimum grade point average equivalent to 2.5 on The Pennsylvania State University grading scale (approximately half B and half C). Finally, he must ordinarily have completed in a satisfactory manner a certain minimum of course work in designated areas, the specific courses and amount of required work depending upon the field of advanced study which the student proposes to enter. The minimum grade point average of 2.5 during the last two undergraduate years is a general requirement of the Graduate School. Individual departments may require a higher average for admission in their fields.

The above requirements apply particularly to the student who has recently completed an undergraduate program and is about to begin graduate study. An applicant who has done a year or more of graduate work in a recognized graduate school will be evaluated largely on the basis of the graduate record but with some attention to undergraduate achievement. For a mature person, recognized attainment in a professional field will be considered, and reduced weight will be given to old undergraduate records.

**CONDITIONAL ADMISSION**—Some departments are participating in an experiment on conditional admission for applicants whose undergraduate grade point average is below 2.5 but whose qualifications in other respects seem to suggest probable success in the Graduate School. Such an applicant must realize that the initiative rests entirely with him in communicating with the department of his chosen major and that, if admitted conditionally, he does graduate work at his own risk. There is no assurance that he will subsequently be granted unqualified admission or that the credits earned will be applicable toward degree requirements. Applicants for admission on a conditional basis must have all of the essential materials for consideration for admission to that status on file with the Dean of the Graduate School at least six weeks before they wish to register in the Graduate School.

**PROVISIONAL ADMISSION**—Provisional admission may be granted to an applicant whose complete credentials are not available at the time of registration, but this admission will be subject to cancellation if the credentials, on their arrival, do not meet the requirements for admission to the Graduate School. Also, while the applicant is holding provisional admission, certification of any scheduled credits will be



## ADMISSION

withheld until receipt of his official credentials makes possible his unqualified admission to the Graduate School. If the provisional admission should, for any reason, be canceled, the student is thereby automatically dropped from the Graduate School and as a consequence will be required to cease attending any 500-level courses for which he may have registered. He may continue to attend 400-level courses provided he applies for and is accepted for registration as a special student.

**ADVISERS**—To assist the student in planning his program, the head of his major department will designate a member of the faculty to serve as adviser. It is the student's responsibility to secure the name of his adviser from the department head and to seek a conference before registration.

**ENGLISH PROFICIENCY OF FOREIGN STUDENTS**—Entering graduate students from countries other than the United States are required to demonstrate high level competence in the use of the English language, including reading, writing, speaking, and listening. Upon arrival at the University, such students are requested to make an appointment for an initial language proficiency interview at the Language Testing Center for International Students, 218 Sparks Building. Students with an obviously good command of English will be exempted from formal testing; others will be scheduled for a series of proficiency tests. Remedial work will be prescribed as indicated by the tests.

**GUESTS OF THE UNIVERSITY**—The President of the University, on recommendation of the Dean of the Graduate School, will welcome doctors of philosophy of The Pennsylvania State University, as well as those of other accredited colleges and universities, as guests of the University, with the privilege of attending seminars and courses and of carrying on research. There will be no charge except for laboratory expenses. Arrangements should be made in advance with the Dean of the Graduate School.

**UNDERGRADUATE STUDENTS**—A senior student of The Pennsylvania State University lacking not more than 4 credits for graduation may be admitted to the Graduate School. This limit may be increased to 8 credits in the case of a student with an average of at least B (a grade point average of 3). Any senior with a 3.5 grade point average may be admitted to 500-level courses with the consent of the instructor; other undergraduate students may be admitted to such courses with the consent of the instructor and the Dean of the Graduate School.

In certain cases undergraduate students may subsequently apply credits they have earned in 400 and 500 series courses toward an advanced degree at Penn State. Upon admission to the Graduate School such credits as are relevant to the graduate field of study and were not used to satisfy undergraduate requirements will be entered on the student's graduate transcript. These may then be applied toward an advanced degree provided they are acceptable to the major and minor departments. The time limitation on the completion of a master's degree program applies to these as well as to other credits.

## RETENTION

The University expects that students will conduct themselves in accordance with the standards normally followed by educated men and women and in accordance with the laws of the Nation, State, and Borough. The right is reserved to sever at any time the University connection of any student whose influence is found to be injurious to the standard of morals and scholarship of the student body, or whose conduct is prejudicial to the good name of the University.

A graduate student who fails to maintain satisfactory scholarship may be dropped from the University.

## CLASSIFICATION

### CLASSIFICATION

At the time of admission to the University students are classified as regular graduate, general graduate, special, or undergraduate students depending upon their objectives and qualifications.

A change in classification for a graduate student is arranged through the Graduate School office and, in the case of a change from general to regular status, the approval of the head of the major department in which the student proposes to work is required.

A person holding a baccalaureate degree and working only for permanent certification as a teacher or administrator in the public schools is advised to apply for admission as a general graduate student.

**REGULAR GRADUATE STUDENTS**—Persons who plan to become candidates for advanced degrees at The Pennsylvania State University and have been formally admitted for advanced study in a particular field are designated as regular graduate students. The program of study is developed under the guidance of a department head or his representative.

It should be emphasized that a student is not a "regular graduate student" unless he has been officially admitted to that status. Regular attendance in the Graduate School, or personal plans for future degree candidacy, do not in themselves carry with them the status or privileges of a regular graduate student.

A regular graduate student who has passed a candidacy evaluation is classified as a doctoral candidate.

**GENERAL GRADUATE STUDENTS**—An applicant who meets all requirements for admission to the Graduate School, but who does not wish to work for an advanced degree at this institution, may arrange for a program of work as a general graduate student. This classification includes those who plan to transfer credits to another institution and those who plan a special program of study not leading to an advanced degree.

The adviser for a general graduate student is appointed by the department head most closely associated with the student's field of interest. The student's status and standing will be reviewed by the Dean of the Graduate School at each registration. He may remain a general graduate student longer than one term only with the permission of the Dean, and for definite and good reasons.

When a general graduate student wishes to become a regular graduate student—i.e., to work for an advanced degree at this institution—he should make application to the Dean of the Graduate School for change of status. His undergraduate record will then be re-evaluated to determine whether or not he is prepared to undertake graduate work for a degree in the major field of his choice. He should understand that he may thereafter apply toward degree requirements only those credits earned as a general graduate student which fit definitely and logically into an integrated degree program. There is no upper limit to the number of credits that may be so applied; neither is there a guarantee that any such credits may be applicable.

**SPECIAL STUDENTS**—A special student is not a graduate student, inasmuch as he has not been admitted to the Graduate School, and may not register for graduate courses or research (500 and 600 series) without permission of the Dean of the Graduate School. A special student may register for 400-level courses, provided he has attained at least junior standing in college.

### REGISTRATION

The responsibility for being properly registered rests with the student. At least until he has met the minimum requirements for his degree, he must register for each term in which he proposes to do either course work or research, or other work on his



## REGISTRATION

thesis, either on or off campus. In the case of research the number of credits shall be determined by the amount of time required for the investigation, one credit representing one week of full-time graduate work.

**CONTINUITY OF REGISTRATION**—Beginning with the fall term 1962 any student who has interrupted the normal sequence of his graduate program will be required to apply to the Dean of the Graduate School for permission to resume graduate study. It is recognized that certain students typically will not attend the summer terms whereas others will concentrate their work in these terms. The new policy recognizes both groups, as well as certain variants, as meeting the spirit of the policy.

In order to register for a given term, a student who has been previously enrolled will need to apply unless he has been registered for work at University Park, for thesis research in *absentia* (610), or for other Penn State work off campus during certain specific terms as follows:

Summer Term—Application required unless the student was registered for the preceding summer term or the preceding spring term.

Fall Term—Application required unless the student was registered for the preceding spring term or the preceding summer term.

Winter Term—Application required unless the student was registered for the preceding fall term.

Spring Term—Application required unless the student was registered for the preceding winter term.

**PROCEDURE**—For each registration the student, in consultation with his adviser, prepares a schedule of courses and research designed to fit his individual needs, which is submitted to the Dean of the Graduate School for his approval. The registration process is completed in the manner specified for all students at the University.

Under certain conditions credit may be earned by work done off the campus. A student contemplating such work should inquire of the Dean of the Graduate School about the procedures and conditions. Such work must be scheduled *in advance* in the regular manner.

A resident student is required to register in person, not by proxy. A nonresident student is expected to assume responsibility for initiating the registration process, but the details can be handled by mail.

A student must register for courses audited as well as for those taken for credit.

**EXCEPTIONS**—When a candidate has met minimum requirements for a degree, further registration shall be required only for course work, project work, and research work requiring the use of University facilities and supplies (including laboratory, library, and others). This means, for instance, that if a student has completed nine terms of work (90 credits) of a doctoral program, has completed his research on campus, and has permission from the Dean to complete his work *in absentia*, he need not register for credits. Similarly, a student who has earned 90 credits, but who still has much research to do which does *not* involve using University facilities, and who receives permission to complete his work at, for example, the Library of Congress, need not register. On the other hand, a student who uses University facilities for all of his research must be registered for credit at all times, regardless of the number of credits that may accrue before he completes his work.

A candidate need not register for the term at the end of which the degree is to be conferred solely for the purpose of graduating. He will, of course, be required to register if he has a significant amount of work to complete unless relieved of this obligation by the previous paragraph. He will not be required to register if he has only minor revisions of his thesis to complete and/or the final oral examination to pass.

**TIME OF REGISTRATION**—The regular registration days are indicated in the University Calendar. Graduate students follow the same registration schedule as undergraduates do.



## ACADEMIC LOAD

A student is expected to complete his registration during the officially designated period and to attend the first meeting of all classes in which he is enrolling. If this is impossible because of some emergency or unusual circumstance beyond his control, the student may be granted permission by his instructors to miss a few class meetings, it being understood that work missed will be made up subsequently. Under these conditions the Dean of the Graduate School may grant the student permission to register late. In general, a student who receives permission to register late will be required to reduce his program in proportion to the amount of time which he has been absent.

Regardless of when he may begin attending classes, a student who fails to complete the process of registration within the officially designated registration period will be liable for the late registration charge.

**LOADS, ACADEMIC AND EMPLOYMENT**—Many students depend upon part-time employment to help meet their expenses. A student who is thus employed, however, must recognize the time demands of his work schedule in planning his academic program.

The University takes the position that the facilities of the Graduate School should be made available only to students who can profit from their Graduate School experience to a maximum extent. Therefore the Graduate School reserves the right to deny admission or registration to part-time students who (a) propose schedules of few credits which seem to reflect little real interest in graduate work or would not seem to require serious effort, or (b) wish to carry overloads of such proportion as to handicap them seriously in achieving maximum quality in their graduate work.

“Doing graduate work” means more than doing what is required in courses or in research. It means living in a scholarly atmosphere and seriously engaging in scholarly pursuits. It means profiting from hearing visiting scholars and artists and from engaging in discussions, both formal and informal, with faculty members and fellow students. It should mean leisure time for reflection and for exploring fields related to, although not directly a part of, one’s specialty. Overloads make it difficult and often impossible to do graduate work so conceived. Hence the following “protective” schedule of permitted loads for employed students has been adopted:

EMPLOYMENT	ACADEMIC LOAD
0 hours per week	8-10 credits allowed
10 hours per week	7- 9 credits allowed
20 hours per week	5- 7 credits allowed
30 hours per week	4- 5 credits allowed
40 hours per week	1- 4 credits allowed

This means, for example, that anyone working 20 hours per week (about half-time) whether as a half-time graduate assistant, as an employee on campus, or as an employee off-campus, will be limited in the amount of graduate work for which he may register to about three fifths of a normal full-time load (i.e., to 5-7 credits). The word employment is used in a very general sense and includes working for indirect compensation, such as housekeeping, working in the family business, maintaining a large vegetable garden, etc. Hence, all students who are thus employed will be expected to adjust their academic loads accordingly. Exceptions, in the case of students who have demonstrated unusual ability, must be arranged with the Dean of the Graduate School at the time of registration. (See also Visiting and Auditing Classes.)

A student holding a fellowship, graduate assistantship, or scholarship may not accept employment of any kind for service beyond that specified by his appointment.

**VISITING AND AUDITING CLASSES**—A graduate student who wishes to attend classes without receiving credit may secure permission either to visit or to audit courses during a term for which he has registered.

## GRADING SYSTEM

As a visitor, a student may attend classes with the approval of the instructor but may not claim the usual privileges of class membership such as participating in discussion, doing practicum work, or taking examinations. He does not register for the privilege of visiting nor does any record appear on his transcript.

As an auditor, a student may participate in class discussion, do practicum work, take examinations, and generally share the privileges of a class member. The student registers in the same manner as if he were taking the course for credit and pays the same fees. He receives no grade and cannot subsequently secure credit for work done in the course.

Ordinarily a student is not permitted to count courses for which he is registered as an auditor as a part of the minimum for which he is required to register by virtue of his status. Beyond the required minimum he may register for credit or audit but may not exceed the normal maximum without special permission.

In general, students are encouraged to visit classes rather than to register for the course as an auditor.

In the 1G and 2G courses offered by the language departments, visiting is not permitted and no distinction is made between registering for credit and for audit in considering loads. If the student does not have a reasonable background in the language, he will be required to count the course as a part of his permissible load regardless of whether he registers for credit or for audit. If he has had the language before and is taking the course as a refresher, he may, with the permission of the Graduate Dean, take the course as an overload regardless of whether he registers for credit or audit.

**STATUS UNDER SELECTIVE SERVICE**—As soon as an applicant has been admitted to the Graduate School, his local board will be informed *provided* the applicant requests it and has given the necessary information. As soon as he receives notification of admission, the applicant should check with the Associate Registrar to see that everything is in order.

A student is certified to be a full-time student insofar as Selective Service is concerned if he schedules at least 8 credits in a term, or if he holds an appointment as a quarter-time or half-time graduate assistant, or if he is serving an internship under approved conditions.

Whenever a student changes his status so as no longer to be considered a full-time student, fails to make satisfactory progress, or makes a drastic change in his declared goal, his local board will be notified.

## GRADING SYSTEM

A grade is given solely on the basis of the instructor's judgment as to the student's scholarly attainment.

For graduate courses (500 series) and for research or thesis (600 or 610) one of three grades may be given:

H for Honors, indicating definitely superior attainment.

P for Pass, indicating acceptable but not superior attainment.

F for Fail, indicating failure to attain the acceptable minimum standard of work or to spend an adequate amount of time doing the work scheduled.

In addition to the quality grades listed above, two symbols, "deferred" and R, may appear on a student's transcript. If work is incomplete at the end of a term for a reason beyond the student's control, or if very little work remains to be done, the instructor may report "deferred" in place of a grade, which will appear temporarily on the student's record.

In the case of thesis work, either in progress or completed, the instructor may report the symbol R in place of a grade. This symbol indicates that the student has devoted an adequate amount of time to the work scheduled but gives no indication



## TUITION AND CHARGES

of its quality. An R remains on the student's transcript permanently. If, after having submitted a series of R symbols, the instructor reports a grade of H, P, or F for a specific term, this grade is considered to apply to the preceding series of registrations and to denote the quality of that entire series.

For 400 series courses one of five grades may be given:

<i>Grade</i>	<i>Percentage Equivalent</i>	<i>Grade Point Equivalent</i>
A	90-100	4
B	80- 89	3
C	70- 79	2
D	60- 69	1
F (Failure)	0- 59	0

Grades below B do not carry graduate credit and are considered failures in the program of a graduate student.

## GRADUATION

It is the responsibility of the student to inform the Graduate Recorder of his intention to graduate, and to pay thesis fees at the beginning of the term in which he expects to receive an advanced degree. Deadlines are given in the calendar.

Attendance at commencement exercises is expected, but permission to receive the degree *in absentia* may be granted by the Dean of the Graduate School for sufficient reasons. See the *Manual for Graduate Students* for a detailed statement of procedure concerning graduation.

All degrees conferred are tentative until final grade reports have been received even though the student's name may have appeared in the commencement program.

## TUITION AND CHARGES

The University reserves the right to revise the schedule of tuition and charges without further notice.

### TOTAL TUITION FOR EACH TERM

*Residents of Pennsylvania*, \$22 per credit with a maximum of \$175 per term.

*Nonresidents of Pennsylvania, on-campus work*, \$44 per credit with a maximum of \$350 per term.

*Nonresidents of Pennsylvania, research in absentia*, \$22 per credit with a maximum of \$175 per term.

*Total charge for a Vocational Education program*, not exceeding 7 credits (vocational education courses are indicated by "v" following the course number), \$22.

Tuition is the same for courses whether taken as an auditor or for credit.

Any student who does not fulfill payment obligations promptly may be charged a late payment fee of \$25. A student whose account is delinquent for more than 10 days is subject to suspension from the University.

Whenever it appears that an applicant for admission is not domiciled in Pennsylvania it is assumed that he is a non-Pennsylvanian. If the student who is thus admitted believes that his circumstances do not justify his classification as a non-Pennsylvanian, he may petition the Dean of Admissions for reclassification.

When a petition for reclassification is made, the petitioner is required to present proof of a bona fide continuous domicile of the one admitted (or of his parents, if he is a minor) within the Commonwealth for a period of at least 12 months immedi-



## LIVING ACCOMMODATIONS

ately preceding the date of such petition for reclassification; and, in addition, such other evidence as is pertinent to a complete review of his classification.

Any student who changes his domicile while attending the University is subject to reclassification effective at the beginning of the first term following the twelfth month after such change has taken place.

**TUITION REFUND POLICY**—Charges for tuition are refundable upon withdrawal from the University only in the event the student obtains an Official Withdrawal Form at the office of the Dean of the Graduate School and presents it, together with his current Certificate of Registration, at the office of the Fee Assessor not later than one calendar month after the effective date of withdrawal from classes. Students who meet these conditions are entitled to receive refunds of charges for tuition for the term in accordance with the following schedule:

Refund of 80 per cent upon withdrawal before the end of the first week of the term (seventh consecutive calendar day from the first day of classes) and a decrease of 20 per cent for each week thereafter up to and including the fourth consecutive calendar week. No amount will be refunded for withdrawal after the fourth consecutive calendar week of the term.

The University will not release any refund of tuition until at least three weeks have elapsed from the date the payment was received. All refunds will be made by check and mailed to the student's home address.

**SPECIAL CHARGES** (payable as occasion demands and applicable to all students):

Admission to the Graduate School .....	\$10.00
Privilege of late registration .....	10.00
Privilege of late payment .....	25.00
Change of schedule, each change .....	2.00
Thesis binding fee for master's candidate .....	9.00
Thesis microfilming and binding fee for doctoral candidate .....	44.00
Official transcript of record (with seal), each copy .....	1.00

**MOTOR VEHICLE CHARGES**—Each graduate student who possesses, maintains, or operates a motor vehicle (including motorcycles, motor bikes, motor scooters, or any other motor-driven vehicle) in Centre County is required to register such vehicle with the Traffic Violations Officer during the registration period of each term. There is no charge for registration for students who do not desire campus driving or parking privileges. Failure to register a vehicle renders a student liable for a fine of \$25 for each offense.

A permit allowing driving and parking on the campus throughout the week costs \$10 per term. A more restricted permit allowing driving and parking on the campus for evenings and weekends costs only \$3.50 per term.

A graduate assistant pays no fee for the privilege of driving and parking on the campus but is required to comply with student regulations concerning motor vehicles.

A graduate student planning to operate a motor vehicle in the State College area should secure a copy of the leaflet *Parking and Traffic Regulations* from the Traffic Violations Officer, Room 203D Hetzel Union Building.

## LIVING ACCOMMODATIONS

Eastview Terrace and Graduate Circle, both located on the eastern side of the campus, provide one- and two-bedroom apartments for married graduate students.

The Eastview Terrace apartments are fireproof, one-story, steel framework buildings. Forty-six one-bedroom units rent for \$65 per month and 32 two-bedroom units rent for \$75. The rent includes utilities except for electricity. Hot water is heated electrically. The units are unfurnished except for electric stove and refrigerator.

## STUDENT AIDS

For each two units, there is a utility room with two stationary laundry tubs and storage space.

Graduate Circle, opened in 1960, has 144 one-bedroom and 72 two-bedroom apartments in 16 two-story buildings of brick and frame construction. The units rent for \$82.50 and \$92.50 per month, including all utilities. The kitchens have double stainless steel sinks with disposal unit, a gas stove, kitchen cabinets, electric refrigerator, and a built-in chest of drawers in the bedroom; otherwise the units are unfurnished. There are no facilities for private washing machines in the apartments; however, coin-operated laundries at nominal fees are provided in five of the buildings throughout the area. A storage locker is also provided for each apartment at the laundry location.

Families with children of school age cannot be considered for occupancy in Eastview Terrace and Graduate Circle. The one-bedroom apartments are designed for a husband and wife and the two-bedroom units for a family with not more than two children. An application form for a Married Student Apartment may be obtained by writing to the Department of Housing and Food Services, 23 Pollock Dining Hall, The Pennsylvania State University, University Park, Pa. Telephone: Area Code 814, UN 5-7501.

A married student may also find accommodations in off-campus apartments, trailers, or rooms in private homes.

Irvin Hall and Grange Hall, both located on central campus, provide for single students, both men and women. For detailed information write to Department of Housing and Food Services, 23 Pollock Dining Hall, The Pennsylvania State University, University Park, Pa. Telephone: Area Code 814, UN 5-7501. Other living accommodations are available, including rooms in private homes and lodging houses. The cost varies considerably depending upon the type of accommodation. The prospective student should make arrangements well in advance of the beginning of classes because it may be very difficult to find a convenient location at the last minute. Boarding houses, restaurants, and the Hetzel Union Cafeteria on the campus are available for meals.

## STUDENT AIDS

In every case in which a graduate assistantship, fellowship, grant-in-aid, or scholarship for the next academic year is offered to an actual or prospective graduate student, the student, if he indicates his acceptance before April 15, will have complete freedom through April 15 to submit in writing a resignation of his appointment in order to accept one elsewhere. However, an acceptance given or left in force after April 15 commits him not to accept another appointment without first obtaining formal release for the purpose.

## ASSISTANTSHIPS

Approximately 1,000 graduate assistantships are awarded annually. Most of these are half-time, but a limited number of quarter-time and three-quarter-time assistantships are available in some departments. An appointee may serve as an assistant in classroom or laboratory instruction, or in research or other work.

A prospective student should write directly to the head of his major department for information and application forms. Appointments are made upon the recommendation of the department head, subject to admission to the Graduate School. Clear evidence of superior ability and promise is required. Reappointment to an assistantship requires a continuing demonstration of good scholarship.

The assistantships vary as follows:



## FELLOWSHIPS

**QUARTER-TIME**—The student may schedule 7-9 credits, receives a stipend in the range \$219-\$375 plus a grant-in-aid which covers tuition, will be required to give about 10 hours of service per week for 12 weeks, and will be considered to be following a full-time course of instruction under Selective Service regulations.

**HALF-TIME**—The student may schedule 5-7 credits, receives a stipend in the range \$438-\$750 plus a grant-in-aid which covers tuition, will be required to give about 20 hours of service per week for 12 weeks, and will be considered to be following a full-time course of instruction under Selective Service regulations.

**THREE-QUARTER-TIME**—The student may schedule 4-5 credits, receives a stipend in the range \$657-\$1,125 plus a grant-in-aid which covers tuition, will be required to give about 30 hours of service per week for 12 weeks, and will be considered a part-time student.

In addition to receiving a grant-in-aid to cover full tuition during the term of appointment, a graduate assistant who is completing three or more consecutive terms of service is entitled to apply for a grant-in-aid to cover tuition for the succeeding term without service, if he is not receiving a scholarship or fellowship from another source during the term. To receive this privilege a student must apply to the head of the department in which he has held the assistantship.

A graduate assistant may not accept additional employment, either at the University or elsewhere, during the period for which service to the University is required under the appointment.

A graduate assistant pays no fee for the privilege of driving and parking on the campus but is required to comply with student regulations concerning motor vehicles.

## FELLOWSHIPS

More than 150 fellowships are awarded annually. Recipients must be superior students and are frequently required to have completed a certain minimum of graduate work before being eligible for an award. Fellows carry a full-time graduate program, receive a stipend which varies with the award, and receive a grant-in-aid paid by the donor of the fellowship to provide for all tuition. They may not accept employment during the term of their appointment, nor are they required to render any service to the University. In some cases a fellow will be expected to limit his research to a broad field specified by the donor. Fellows are required to pay specific charges, such as admission, late registration, change of schedule, thesis binding, microfilming, and parking fees.

**GRADUATE SCHOOL FELLOWSHIPS**—Eleven fellowships, each paying a stipend of \$2,000 for the fall, winter, and spring terms, and providing a grant-in-aid to cover all tuition charges for these terms, are given by the University and are designated as Graduate School Fellowships. They are available to outstanding advanced graduate students in any field, although preference is given to applicants majoring in the humanities and social sciences. An applicant must have completed at least one full year of graduate study prior to beginning the fellowship tenure and be a candidate for the doctoral degree.

Applications should be addressed to the Dean of the Graduate School and must be received by March 1 to be considered for the following fall, winter, and spring.

**FELLOWSHIPS FROM FOUNDATIONS AND INDUSTRIES**—At least 90 such fellowships, with various stipends, are awarded through the individual departments. Information and application forms may be secured from the head of the major department concerned. The fellowships which are awarded will vary somewhat from year to year, but the following are typical of those which were available for 1961-62:

**AMERICAN CHEMICAL SOCIETY (PETROLEUM RESEARCH FUND)**—Open to graduate students in chemistry and chemical engineering; stipend \$2,000-\$2,400.



## FELLOWSHIPS

AMERICAN CHEMICAL SOCIETY (PETROLEUM RESEARCH FUND)—Open to graduate students in fuel technology; stipend \$2,280.

AMERICAN CHEMICAL SOCIETY (PETROLEUM RESEARCH FUND) (2)—Open to graduate students in geochemistry, mineralogy, and solid state technology; stipend \$2,400.

AMERICAN CHEMICAL SOCIETY (PETROLEUM RESEARCH FUND)—Open to graduate students in geology; stipend \$2,400.

AMERICAN CYANAMID FELLOWSHIP IN CHEMISTRY AND CHEMICAL ENGINEERING—Open to a graduate student for the final year of study leading to the Ph.D. degree. Awarded in alternate years to a chemist and to a chemical engineer; stipend \$1,800.

AMERICAN IRON AND STEEL INSTITUTE (2)—Open to graduate students in geochemistry and metallurgy; stipend \$2,400.

AMERICAN PETROLEUM INSTITUTE FELLOWSHIPS (5)—Open to graduate students in chemistry and physics for research concerning the synthesis and properties of high molecular weight hydrocarbons; stipend \$1,710-\$2,280.

AMERICAN PETROLEUM INSTITUTE FELLOWSHIPS (2)—Open to graduate students in geochemistry, ceramic technology, mineralogy, and solid state technology for research concerning the synthesis and properties of clays and related inorganic phases; stipend \$2,280-\$2,400.

AMERICAN PETROLEUM INSTITUTE DRILLING RESEARCH FELLOWSHIP—Open to graduate students in mining or petroleum and natural gas engineering for studies related to drilling and rock penetration; stipend \$2,400.

AMERICAN ZINC INSTITUTE FELLOWSHIP—In support of graduate research involving zinc or its compounds. Open to students in solid state technology, geochemistry, or allied fields; stipend \$2,400.

AMERICAN ZINC INSTITUTE FELLOWSHIPS (2)—Open to students in ceramic technology; stipend \$2,000.

ARMSTRONG SUMMER FELLOWSHIPS IN CHEMISTRY (5)—Open to graduate students in chemistry; stipend \$640.

THE MICHAEL BAKER, JR., FELLOWSHIP IN PUBLIC ADMINISTRATION—Available to a candidate for a master's degree in public administration; stipend \$2,000-\$2,200.

BASIC, INC., FELLOWSHIP—Open to graduate students in ceramic technology; stipend \$2,400.

THE CAROLINE CAPOZZOLA FELLOWSHIP—Available to a candidate for a master's degree in public administration; stipend \$2,000-\$2,200.

CARBORUNDUM CORPORATION FELLOWSHIP—Available to a graduate student in mineral preparation; stipend \$2,400.

CONTINENTAL OIL COMPANY FELLOWSHIP—Available to graduate students in petroleum and natural gas engineering for studies in petroleum engineering; stipend \$2,280.

CORNING GLASS WORKS FOUNDATION FELLOWSHIP—In support of graduate work on glass or any of its components; stipend \$2,400.

ESSO RESEARCH AND ENGINEERING POSTGRADUATE FELLOWSHIP IN CHEMISTRY AND CHEMICAL ENGINEERING—Open to advanced graduate students for one year of study leading to the Ph.D. degree; stipend \$1,800-\$2,400.

ETHYL CORPORATION FELLOWSHIP—Open to graduate students in chemistry; stipend \$2,100.

W. S. ELLIOTT FELLOWSHIP—Available to a graduate student who is a Penn State graduate and is interested in engineering research; stipend \$1,200.

GENERAL ATOMIC DIVISION OF GENERAL DYNAMICS CORPORATION FELLOWSHIP—Open to graduate students in physics; stipend \$2,500.

GENERAL FOODS FUND FELLOWSHIPS (2)—For graduate work with a major in home economics; stipend for doctoral \$3,000, for master's \$2,000.

GULF OIL COMPANY FELLOWSHIP IN PETROLEUM AND NATURAL GAS ENGINEERING—For graduate work in petroleum production; stipend \$2,400.

HAMILTON STANDARD FELLOWSHIP—Open to graduates of this University in aerospace, electrical, and mechanical engineering, engineering mechanics, and physics; stipend \$1,800.

## FELLOWSHIPS

INTERNATIONAL BUSINESS MACHINES CORPORATION FELLOWSHIP—Open to an outstanding graduate student doing research in physical science or engineering; fellowship rotated annually among certain departments specified by the company; stipend \$1,800-\$2,500.

KOPPER'S SUMMER SUPPLEMENTAL TEACHING FELLOWSHIPS (2)—Open to graduate students in chemistry; stipend \$600.

LEAD INDUSTRIES ASSOCIATION FELLOWSHIP—Open to graduate students in ceramic technology for studies of lead oxide systems; stipend \$1,992.

LEAD INDUSTRIES ASSOCIATION FELLOWSHIP—Open to graduate students in geochemistry, mineralogy, and solid state technology; stipend \$2,400.

MOLYBDENUM CORPORATION OF AMERICA—Open to a graduate student in mineral preparation; stipend \$2,400.

MONSANTO SUMMER RESEARCH FELLOWSHIPS (2)—Open to graduate students in chemistry; stipend \$650.

NATIONAL SCIENCE FOUNDATION COOPERATIVE GRADUATE FELLOWSHIPS—The Graduate School participates in this program of fellowships available in the biological, engineering, mathematical, and physical sciences, anthropology, economics (excluding business administration), geography, history and philosophy of science, psychology (excluding clinical), and sociology (excluding social work). Also included are interdisciplinary fields such as biophysics, geochemistry, and meteorology. Applications for the following year must reach the Dean of the Graduate School by November 1.

OHIO OIL COMPANY FELLOWSHIP IN PETROLEUM AND NATURAL GAS ENGINEERING—Open to graduate students in petroleum engineering; stipend \$2,000.

EDWARD ORTON, JR., CERAMIC FOUNDATION FELLOWSHIP—Open to students in ceramic technology for studies relating to kiln-fired ceramic bodies; stipend \$2,400.

OWENS-CORNING FIBERGLAS FELLOWSHIP IN CERAMIC TECHNOLOGY—Open to graduate students in ceramic technology; stipend \$3,000.

OWENS-ILLINOIS FELLOWSHIP—Open to graduate students in ceramic technology for studies in glass science and technology; stipend \$3,000.

PENNSYLVANIA COOPERATIVE WILDLIFE ASSOCIATION (2)—Available to graduate students in forestry; stipend \$1,872-\$2,024.

PENNSYLVANIA NATURAL GAS MEN'S FELLOWSHIP—For graduate work in petroleum and natural gas engineering for studies in gas technology; stipend \$2,000.

PENNSYLVANIA POWER AND LIGHT COMPANY FELLOWSHIP—Open to graduate students in mineral preparation; stipend \$2,400.

PFADLER-PERMUTIT FELLOWSHIP—Open to students in ceramic technology; stipend \$3,000.

PITTSBURGH PLATE GLASS FELLOWSHIP—Open to graduate students in ceramic technology for fundamental studies of glass; stipend \$3,000.

RADIO CORPORATION OF AMERICA FELLOWSHIP—Open to graduate students in electrical engineering; stipend \$2,520.

SHELL FELLOWSHIP IN CHEMICAL ENGINEERING—Open to graduate students in chemical engineering for the final year of study leading to the Ph.D. degree; stipend \$2,400.

SHELL FELLOWSHIP IN CHEMISTRY—Open to a graduate student in chemistry; stipend \$2,100.

SHELL SUMMER FELLOWSHIPS IN CHEMISTRY (4)—Open to graduate students in chemistry; stipend \$750.

SOCONY-MOBIL OIL FELLOWSHIP—Available for graduate students in chemical engineering; stipend \$2,000.

SPEER CARBON FELLOWSHIP—Open to graduate students in fuel technology for studies on carbon; stipend \$2,400.

STACKPOLE FERRITE FELLOWSHIP—Open to students in ceramic technology and solid state technology; stipend \$3,000.

STACKPOLE FELLOWSHIP IN METALLURGY—Open to graduate students in metallurgy for studies in powder metallurgy; stipend \$2,280.



## FELLOWSHIPS

**SPRAGUE ELECTRIC COMPANY FELLOWSHIP**—Open to students in ceramic technology and solid state technology; stipend \$2,400.

**STAUFFER CHEMICAL COMPANY FELLOWSHIP IN CHEMISTRY**—Open to a graduate student in chemistry for research on organometallic compounds; stipend \$1,800.

**SUN OIL COMPANY FELLOWSHIP IN CHEMISTRY**—Open to the incoming graduate student who is judged to offer the greatest promise for a successful career in chemistry; stipend \$3,000.

**TEXACO, INC., FELLOWSHIP**—Open to a graduate student in physics; stipend \$3,000.

**UNION CARBIDE METALS FELLOWSHIP**—Open to graduate students in metallurgy; stipend \$2,280.

**U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE: OFFICE OF VOCATIONAL REHABILITATION TRAINEESHIPS IN VOCATIONAL REHABILITATION COUNSELING (36)**—Open to graduate students in the Department of Educational Services who are specializing in vocational rehabilitation counseling; stipend \$1,800-\$2,000.

**U. S. PUBLIC HEALTH SERVICE TRAINEESHIPS IN CLINICAL PSYCHOLOGY (7) AND IN SCHOOL PSYCHOLOGY (3)**—Open to selected graduate students in these areas of psychology; stipend \$1,800-\$3,000.

**U. S. PUBLIC HEALTH SERVICE TRAINEESHIPS IN PUBLIC HEALTH NUTRITION**—Open to selected graduate students in foods and nutrition; stipend \$3,000.

**UNITED STATES STEEL FOUNDATION FELLOWSHIP**—Open to graduate students in the College of Mineral Industries for studies related to steel-making; stipend \$2,880.

**VETERANS ADMINISTRATION INTERNSHIPS IN CLINICAL PSYCHOLOGY (18)**—Open to selected advanced graduate students in this area of psychology.

**WHEELABRATOR FELLOWSHIP**—Open to graduate students in industrial engineering, mechanical engineering, and metallurgy; stipend \$1,500.

In addition, numerous grants are available from governmental agencies, industrial concerns, and foundations for the support of investigations of particular problems. Many of these permit full-time study and carry the same exemptions as the fellowships listed above. Detailed information may be secured from departments.

**EXTERNALLY ADMINISTERED FELLOWSHIPS**—Attention is directed to the following fellowships which are awarded nationally and may be used at the university of the recipient's choice:

**ATOMIC ENERGY COMMISSION SPECIAL FELLOWSHIPS IN NUCLEAR SCIENCE AND ENGINEERING**—These fellowships are available to United States citizens who hold bachelors' degrees in engineering or physical science (chemistry, earth science, mathematics, or physics) and who have completed mathematics through ordinary differential equations. Applicants for first-year fellowships will be required to take the Graduate Record Examinations designed to test aptitude and achievement, which are administered in January at a large number of centers in the United States and overseas. Before a fellowship appointment becomes effective, the fellow must be granted fellowship clearance by the Atomic Energy Commission and must be accepted by a participating university for study leading to an advanced degree. The deadline for filing applications for fellowships beginning in September is the first of the preceding January. Forms may be obtained from the NSE Fellowship Office, Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tennessee.

**NATIONAL INSTITUTES OF HEALTH FELLOWSHIPS**—Available to graduate students in the basic sciences, such as biology, chemistry, zoology, physiology, biochemistry, etc., as they relate to problems of health and disease; and among the social sciences, those areas, such as psychology and sociology, which relate to the problems of health and disease and some interdisciplinary fields such as biostatistics, medical economics, cultural anthropology, etc. These fellowships are used at the university of one's choice, and application should be made to the Career Development Review Branch, Division of Research Grants, National Institutes of Health, Bethesda, Maryland, by October 1, February 1, or May 1 to be considered at the December, April, or July review periods respectively.



## OTHER AIDS

**NATIONAL SCIENCE FOUNDATION GRADUATE FELLOWSHIPS**—These fellowships, which are somewhat different from the NSF Cooperative Fellowships mentioned above, are also awarded for graduate study in the biological, engineering, mathematical, and physical sciences, anthropology, economics (excluding business administration), geography, history and philosophy of science, psychology (excluding clinical), and sociology (excluding social work). Also included are interdisciplinary fields such as biophysics, geochemistry, and meteorology. These fellowships are used at the university of one's choice. Application is made during the fall to the National Science Foundation, Washington 25, D. C. The application deadline is usually about January 1.

**WOODROW WILSON NATIONAL FELLOWSHIPS**—Awarded by the Woodrow Wilson National Fellowship Foundation for first year graduate study at the institution of one's choice, to outstanding students who show a clear preference for a career in college teaching, especially in the areas of the humanities and social sciences. In exceptional cases consideration will be given to students in the natural sciences.

A student must be nominated by a professor in his undergraduate college, the nomination being sent to the regional chairman of the Woodrow Wilson Fellowships for the area in which that college is located. Applicants should consult the dean or other official of their college or write to the Woodrow Wilson National Fellowship Foundation, Box 642, Princeton, N. J. Nominations must reach the regional chairman by October 31.

## OTHER AIDS

**COUNSELORSHIPS FOR MEN**—A number of appointments are available to men graduate students to serve as Resident Counselors in the undergraduate residence halls for men. A counselor's responsibility is to work for the social, academic, and emotional adjustment of the undergraduate residents. Specialized training in personnel work is desirable, though not essential.

These appointments are for three terms (fall, winter, and spring) and provide the recipient with room and board and a grant-in-aid for full tuition. A more limited number of appointments are available during the summer term. A counselor may not hold a fellowship or assistantship during the term of his appointment as a counselor. He may not engage in any other form of part-time employment. He may carry 7 to 9 credits per term.

Requests for information and application forms should be addressed to the Dean of Men.

**SENIOR RESIDENT POSITIONS FOR WOMEN**—Full-time salaried appointments as Senior Residents in undergraduate halls for women are available to qualified women graduate students. Responsibilities include working with student groups in a programming capacity, counseling, and supervising the residence hall during the evening.

These positions permit the holders to take 4 graduate credits per term at \$5.50 per credit. Appointments are made for the fall, winter, and spring terms. Special arrangements of hours of work and credits may be made for the summer term. It is thus possible to complete work for a master's degree in nine terms.

Requests for information and application forms should be addressed to the Dean of Women.

**GRADUATE GRANTS-IN-AID**—Forty grants for full-time study are awarded each year on a term basis, providing for all tuition. They are available to any student on the basis of financial need and academic promise. A recipient is expected to carry a full program of graduate work but may accept employment with the University or another employer not to exceed 10 hours per week, provided he reduces his academic load to 8 or 9 credits. Application for renewal of the grant-in-aid may be made for

## OTHER AIDS

succeeding terms. The value of these grants to Pennsylvanians is \$175 per term, to non-Pennsylvanians, \$350 per term.

Applications should be addressed to the Dean of the Graduate School and must be received by March 15 to be considered for the following summer or fall.

**DU PONT TEACHING AWARD IN CHEMISTRY**—To be eligible for the E. I. du Pont de Nemours and Company Postgraduate Teaching Assistant Award, a graduate student must be currently serving as a part-time teaching assistant and preferably should have had two years of experience in this capacity. The recipient receives \$1,200 in addition to the regular stipend paid him as a teaching assistant.

**JOHN W. WHITE FELLOWSHIP**—Awarded to two graduates of The Pennsylvania State University each year on the basis of scholarship, need, character, and attitude. The recipients may enroll in any approved college or university.

**SCHOLARSHIPS**—A number of scholarships furnished by outside agencies and organizations are awarded annually through individual departments. A request for information should be directed to the department head in the field of the student's major interest.

**A.A.U.W. SCHOLARSHIP**—The State College Chapter of the American Association of University Women has established a modest scholarship which is awarded annually to honor an outstanding woman graduate student. The award does not include exemption from tuition. Nominations are made by departments.

**GENERAL LOAN FUNDS**—Such funds are available from two sources: (1) University loan funds, in limited amounts; (2) loan funds received by the University under Title II of the National Defense Education Act of 1958. Graduate students who are classified as full-time students by the Dean of the Graduate School are eligible for a loan. Information and application forms may be obtained from the director of the Office of Student Aid, 218 Willard Building.

**ASSURED EDUCATION PLAN**—The University offers to the parents (or guardians) of students the Assured Education Plan, enabling them to pay University bills out of current income on a monthly basis. It is available to parents residing anywhere in the United States. There are two plans, one covering a single year's expenses, the other covering two to five years' expenses in a single contract. Life insurance and total and permanent disability insurance are a part of the plan for a parent up to his 68th and 61st birthdays respectively.

In the one-year plan repayment may be made in 8, 10, or 12 monthly payments, the credit service charge being 2½ per cent, 3½ per cent, or 4 per cent respectively. The charge for the insurance is 62 cents a month for each \$1,000.

Under certain conditions graduate students may sign their own agreements under the one-year plan only. The student, or spouse, if any, must be at least 21 years of age, employed, and furnish credit information. If married, the spouse must sign the agreement with the student. Repayment must be made in one year, except for terminal year students, who may have 24 months for repayment. Further information and application forms may be obtained from the Office of the Bursar.

**GRADUATE SCHOOL EMERGENCY LOAN FUND**—This fund has been established through the efforts of the University Alumni Fund and contributions of Graduate School alumni who have received their bachelor's degrees elsewhere. The Graduate Student Association recently made a sizable contribution to it. The purpose of this fund is to assist graduate students on a short-term loan basis in meeting somewhat unexpected financial obligations associated with receiving a degree, such as thesis typing, thesis binding and microfilming fee, job interview travel, etc.

Loans may not exceed \$200. The fund is administered by the Dean of the Graduate School, and application forms may be obtained at his office.



## STUDENT SERVICES

**STUDENT EMPLOYMENT**—Many students depend upon part-time employment to help meet their expenses. A student who is thus employed, however, must recognize the time demands of his work schedule and will be required to adjust his academic load accordingly.

A student who holds a graduate assistantship or a fellowship may not accept employment, either at the University or elsewhere, during the period of his appointment, except as stipulated in certain foundation and federal fellowship programs.

The Office of Student Aid, 218 Willard Building, offers assistance to students in finding part-time employment in town as well as on the campus.

**VETERANS BENEFITS**—The Coordinator of Veterans Affairs has the responsibility of handling all applications for benefits under the various Public Laws.

Under Public Law 550, a student is classified as to his rate of training on the basis of the type of program he is following and the number of credits for which he registers.

## STUDENT SERVICES

**HEALTH CENTER**—The services of the Ritenour Health Center are available to graduate students registered for 8 or more credits and to all graduate assistants, fellows, and other holders of graduate tuition grants.

Students are entitled to five days' free treatment in the University Hospital each term. For each day of confinement in excess of five days a charge of \$10 will be made. Almost all modern drugs are furnished free of charge as required for treatment, but the student may be charged extra for medication where such treatment is unusual or extremely expensive. Consult the *Manual for Graduate Students* for details concerning facilities and services.

**INSURANCE PLAN**—A voluntary Accident and Sickness Insurance Plan with a variety of benefits is available to graduate students and their families. The Student Government Association, which operates the plan, has offices in Room 203A Hetzel Union Building, University Park, Pa. Telephone: Area Code 814, UN 5-4952.

**PLACEMENT SERVICE**—The University Placement Service coordinates the placement activities of all the Colleges and the Graduate School. It is available to any student who is in need of counseling or guidance on employment problems. The services of the following sections are available to the student without charge.

The General Placement Section functions primarily as a clearing house, bringing together students, alumni, faculty members, and representatives of organizations that are seeking college-trained personnel. Summer jobs other than those at camps or resorts are listed at this office.

The Teacher Placement Section assist seniors, alumni, and graduate students in all departments in securing teaching positions.

**RELIGIOUS PROGRAMS**—The University seeks to serve the spiritual needs of its students and staff. General responsibility for religious activity on the campus rests with the University Chaplain and Coordinator of Religious Affairs. Individual organizations under the sponsorship of members of the Jewish, Protestant, and Roman Catholic faiths serve the student body. Many other religious organizations, including denominational and interdenominational groups, are active on the campus and in association with local churches.

**STUDENT AFFAIRS**—The Graduate Student Association is the official University-wide organization of graduate students. All students have membership in the Association, which promotes the general welfare and the academic interests of graduate students. It publishes the *Graduate School Newsletter*, helps to sponsor the Graduate School lecture series, and sponsors social functions.



## MASTERS' DEGREES

The Graduate School recognizes a difference in purpose, which is reflected in the requirements, for two types of advanced degrees: academic and professional. Of the eight masters' degrees conferred, the Master of Arts and the Master of Science are academic in nature. The professional degrees conferred are Master of Agriculture, Master of Business Administration, Master of Education, Master of Engineering, Master of Forestry, and Master of Public Administration.

A degree is not conferred for a mere collection of credits. A well-balanced, unified, and complete program of study will be required, which may frequently exceed the minimum requirements specified below.

A student may meet the degree requirements by either full-time or part-time enrollment and by attendance in any combination of terms. The student who interrupts the continuity of his registration faces the possibility of not being granted permission to return.

**TIME LIMITATION**—All requirements for a master's degree, whether satisfied on the University Park Campus or elsewhere, must be met within six years or a period spanning seven consecutive summers.

**ADMISSION**—Adequate undergraduate preparation is required in the field in which the applicant expects to pursue advanced work. The specific courses and the total number of undergraduate credits required in various areas will be determined by the choice of field and can be ascertained from the descriptive statement appearing under the major field heading in the latter portion of this bulletin. An applicant who meets the minimum grade point average but is deficient in course preparation may, under certain circumstances, be admitted to the Graduate School and allowed to make up the undergraduate deficiencies. Under these circumstances the program will require more than the minimum period of residence. An applicant for admission to the M.Ed. program is required to have had at least 18 credits in education and related psychology, and in certain major fields may be required to have had practice teaching.

After a student has been admitted as a regular graduate student, he should confer with the head of his major department concerning the appointment of an adviser. The general guidance of a master's candidate is the responsibility of an adviser, or of a committee appointed in a manner to be determined by the major department in which the student is specializing. The adviser or the committee assists the student in planning a program of study. Although the adviser is frequently the supervisor of the thesis, this is not necessarily the case.

Requirements concerning courses, language proficiency, minors, comprehensive examinations, and other matters are sometimes made by departments in addition to (but not in conflict with) the regulations of the Graduate School. For details the student should consult the head of the major department.

## M.A. AND M.S.—SPECIFIC REQUIREMENTS

The Master of Arts and the Master of Science degrees have similar requirements, the general major area determining which degree is conferred.

A minimum of 30 graduate credits is required of which at least 20 must be earned on the University Park Campus. A candidate must present a major and either a minor field of study or an approved group of general studies. A minor consists of no fewer than 6 credits of integrated or articulated work in one field related to but different from that of the major. A general studies group consists of no fewer than 6 credits in fields other than that designated as the major field and considered by the major department to have significance and value for the candidate.

At least 18 credits in graduate courses (500 series) and thesis research (600 or 610) combined must be included in the program. A minimum of 12 credits in course work,

as contrasted with research, must be completed in the major field and at least 6 credits must be devoted to a thesis.

The thesis is prepared under the direction of the department in which the candidate's major work is taken. Under certain conditions a student may complete the thesis off-campus. To do so he must make satisfactory arrangements in advance with both the major department and the Dean of the Graduate School.

A *Thesis Information Bulletin*, which gives details concerning format, paper, illustrations, and other items, may be obtained at the Graduate School office.

### M.AGR.—SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Agriculture has a professional orientation and provides training for increased competence in the various fields of agriculture. It should be clearly distinguished from the research-oriented program which leads to the academic degree of Master of Science.

A minimum of 30 graduate credits is required of which at least 20 must be earned on the University Park Campus.

A candidate is required to earn at least 12 credits in graduate courses (500 level) and a minimum of 12 credits outside his major field.

In addition to credit requirements, a candidate must present a paper on a selected professional problem comparable in quality to a thesis in which he applies scientific methods to the solution of a problem. Ability must be demonstrated to (a) formulate and state meaningfully the problem and objectives, (b) critically analyze the present state of knowledge of the problem, (c) acquire and analyze information to help solve the problem, (d) draw logical conclusions, and (e) interpret the relationship between the findings and professional problems. The paper will be evaluated by a committee appointed by the Dean of the Graduate School.

The candidate is required to pass a final examination administered by a committee of three faculty members appointed by the Dean of the Graduate School with at least one member from a department other than that of the candidate's major field.

### M.B.A.—SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Business Administration is designed to develop advanced professional competence in the various fields of business administration. It should be distinguished carefully from the research-oriented programs which lead to the academic degrees of Master of Science and Doctor of Philosophy with a major in Business Administration.

The program requires a minimum of 36 graduate credits of which at least 18 must be at the 500 level and at least 26 must be earned on the University Park Campus. Candidates who enter this program without undergraduate training in business administration may be required to take up to 21 credits of preparatory courses.

Moreover, a candidate is required to present a project paper, comparable in quality and scope of work to a graduate thesis, concerning a problem of a company.

After substantially completing his course requirements, a candidate must pass a comprehensive examination to be administered by a committee composed of graduate faculty members, the first part being written and the second part oral. During these examinations the candidate will be expected to demonstrate his ability to integrate the knowledge gained in the several functional areas of business in a manner which reflects a broad knowledge of his professional responsibilities.

Applicants for the various graduate programs in business administration are required to take the admission test for graduate study in business given by the Educational Testing Service.



## MASTERS' DEGREES

### M.Ed.—SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Education provides preparation for increased professional competence in the several fields of education. It should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Arts or Master of Science.

A minimum of 30 graduate credits is required of which at least 20 must be earned on the University Park Campus and at least 24 must be in course work.

At least 15 credits in 500 series courses is required except in those fields for which the Dean has approved the waiving of this requirement for an experimental period of five years.

**MAJORS IN THE FIELDS OF EDUCATION**—A student may major in one of the approved fields of education, such as elementary education, art education, or home economics education, and proceed under the guidance of the appropriate department of education.

A program of this type requires at least 6 credits to be earned outside the fields of education.

Each candidate takes a diagnostic examination, administered by the Department of Educational Services, which serves as a guide in outlining a program of study to fit his individual needs.

**MAJORS OUTSIDE THE FIELDS OF EDUCATION**—A student who is preparing to teach in a specific subject-matter field, such as chemistry, mathematics, or German, may choose such a field as his major and take the majority of his work in it under the guidance of the department offering that major. A student wishing to work in a broader area may choose such a major as biological science, earth sciences, physical science, or social studies and take at least 24 credits in the area under the guidance of the committee in charge of the major. In this case the student will be expected to choose one field in the area as a primary interest and devote at least 12 credits to it.

Each candidate is required to earn 6 credits in education and to take the examination in educational foundations which is administered by the Department of Educational Services. If adequate background is demonstrated, the candidate may then offer 6 credits in any field of education. If adequate background is not demonstrated, the 6 credits must be in educational foundations, which includes the following specific courses in comparative education, educational measurements and statistics, educational psychology, history of education, and philosophy of education: Ed.Ser. 417, 418, 490, 494, 516, 517, 522, 590; and Psy. 414, 502, 513, 514.

**THESIS OR TERM PAPER**—Six credits may be granted for an approved thesis. Those candidates who do not elect to write a thesis are required to present an essay or term paper. It must be of considerable proportion, indicating capacity to describe a serious intellectual experience adequately in writing, and giving unmistakable evidence of ability to formulate and state meaningfully the purpose of an investigation, study, critical analysis, or evaluation; to acquire and analyze information; to draw conclusions logically; and to relate findings to professional problems and practices. The nature and extent of such a piece of writing, whether it be required in connection with a course or independently of course work, and when it is to be undertaken shall be determined by the major department. The department shall report to the Dean of the Graduate School the title, the name of the faculty member under whom the student did the work, and whether the work was considered adequate. It is the right, but not the responsibility, of the department to require one or more copies of such an essay for its library or other files.



### M.ENG.—SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Engineering provides training for advanced professional competence in the several fields of engineering. It should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Science.

A minimum of 30 graduate credits is required of which at least 12 must be earned in graduate courses (500 series), and at least 6 must be earned outside the candidate's field of concentration.

A scholarly written report on a developmental study involving at least one area represented in the candidate's course work is required as an integral part of the program. The report must be comparable in its level of work and quality to a graduate thesis. The topic of the developmental study is subject to prior approval by the department in which the candidate's major work is taken, and preparation of the written report shall be under the direction of that department.

No work for this degree is required to be done specifically on the University Park Campus provided the major department or supervisory committee agrees that a suitable program can be pursued elsewhere.

### M.F.—SPECIFIC REQUIREMENTS

The program leading to the degree of Master of Forestry provides training for increased professional competence in the several specialized areas of forest resource management and forest products. It should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Science with a major in forestry.

A minimum of 30 graduate credits is required of which at least 20 must be earned on the University Park Campus.

A candidate for the degree of Master of Forestry should choose one area for his major and one or two related areas for his minor. The proportion of credits to be taken in the major and minor fields of study will be determined in consultation with the student's advisory committee. It is expected that the larger part of the program shall be in graduate courses (500 series), but no specific number of credits in the 500 series is required.

Each candidate is required to prepare and submit an acceptable thesis. At least 6 credits of thesis work is required.

### M.P.A.—SPECIFIC REQUIREMENTS

The Master of Public Administration is a professional degree for students who are planning careers in public administration at local, state, national, and international levels or with private and voluntary agencies. This program should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Arts with a major in political science in which the candidate may also specialize in public administration.

For the M.P.A. degree a minimum of 36 graduate credits is required of which at least 6 must be devoted to either a thesis or internship. Students with extensive government experience will write a thesis; others will serve an internship and write a critical review of the experience, the review to be comparable in quality to a thesis. A comprehensive final examination will be required of all students, the examination to be written, oral, or both.

No work for this degree is required to be done specifically on the University Park Campus provided the major department or supervising committee approves its being done elsewhere.

## DOCTORAL DEGREES

The degree is a terminal one and credits earned in the program may or may not be applicable, even in part, toward a doctorate.

### DOCTORAL DEGREES

The Doctor of Philosophy, an academic degree, and the Doctor of Education, a professional degree, are conferred. The two programs are recognized as different in purpose and consequently have different requirements in certain respects.

**ADMISSION**—A student who has been admitted to the Graduate School and has been accepted by the department or committee in charge of a major field in which the doctorate is offered may begin working toward a doctor's degree. However, he has no official status as a doctoral student and no assurance that he will be accepted as a doctoral candidate until he has passed a candidacy examination. This examination is administered by the major department and is given near the end of the first, or at the beginning of the second, year of graduate work including that done for the master's degree and work done elsewhere as well as here (i.e., at about the time he has earned a total of 30 graduate credits).

A new student transferring from another graduate school with 30 or more transfer credits must take this examination before he has earned more than 10 credits here.

**GENERAL REQUIREMENTS**—No specified number of courses completed or credits earned will assure the attainment of the doctorate. The general requirements are based upon a period of residence, the passing of comprehensive examinations, and the writing of a satisfactory thesis. A doctoral program consists of such a combination of courses, seminars, and individual study and research as meets the minimum requirements of the Graduate School and is approved by the doctoral committee for each individual student. It includes work in a major field of study and in either a minor field or a group of general studies.

A master's degree is not a prerequisite for the doctorate. However, the first year of graduate study leading to the Ph.D. may be substantially the same as that provided for the M.A. or M.S. degree. Similarly the first year of the D.Ed. program may be essentially the same as that provided for the M.Ed.

**RESIDENCE REQUIREMENTS**—A minimum of nine terms of full-time graduate study and research, or their equivalent in credits, is required for a doctor's degree. At least 30 credits must be earned in residence at the University Park Campus.

For a period of three terms, two of which must be consecutive, the Ph.D. candidate must limit his work load to half-time at most, the balance of his time being devoted to graduate study. The D.Ed. candidate may meet the residence requirement by enrollment in the summer terms, but increasingly departments are insisting upon the same requirements as for the Ph.D.

A graduate assistant or research assistant who is a candidate for the doctorate, has passed the comprehensive examination, is registered for the maximum allowable credit load, and is certified by his department as devoting all his time to studies and thesis research to meet his degree requirements may be regarded by the Dean of the Graduate School as a full-time student for a period not exceeding one calendar year. Such a student will be considered to earn the equivalent of 10 credits per term and three such terms will meet the minimum residence requirement for the Ph.D.

**OFF-CAMPUS AND TRANSFER CREDITS**—A maximum of two full academic years of work in another approved school granting the doctorate in the major field may be accepted by the Graduate School in partial fulfillment of the requirements for a doctoral degree at The Pennsylvania State University. Not more than one year of work at a graduate school not granting the doctorate in the major field will be ac-



## DOCTORAL DEGREES

cepted here to apply toward doctoral degree requirements. Credit for courses and research work done elsewhere can be used to meet degree requirements, however, only if the work is appropriate to the candidate's proposed program of study as determined by his doctoral committee.

By securing the maximum allowable number of transfer credits, it is possible theoretically to complete the requirements at this institution in three terms. In practice, however, this is rarely possible because of the sequence required in courses and examinations, special departmental requirements, and the possibility of protracted research. It must be remembered that the quality of the program rather than the time requirement is of paramount concern.

Subject to the approval of his adviser, the head of his major department, and the Dean of the Graduate School, a student may register for research to be done away from the University Park Campus. Such work will not be approved, however, simply because the arrangement is convenient for the student; scholarly considerations must determine the choice of location. A doctoral candidate may register for a maximum of 30 credits of research *in absentia*, but these credits must be included in the 60 credits which a candidate may earn in study away from the University Park Campus. The maximum load permitted a student who is employed full time is 4 credits in a term.

A candidate for a doctor's degree may apply toward the minimum requirements a maximum of 10 credits earned in approved classes in Continuing Education or at the Commonwealth Campuses of The Pennsylvania State University.

**ADVISERS AND DOCTORAL COMMITTEES**—After a student has been admitted as a regular graduate student, he should confer with the head of his major department concerning departmental procedures and the appointment of an adviser. The arrangement and approval of the details of the term-by-term schedule of the student is the function of the adviser. This person may be a member of the doctoral committee or someone else designated by the head of the major department for this specific duty.

The general guidance of a doctoral candidate is the responsibility of a doctoral committee consisting of five or more members of the Graduate Faculty. The committee is appointed by the Dean of the Graduate School, upon recommendation of the head of the major department, at the time the student is admitted to candidacy. The chairman of the committee must hold senior membership in the Graduate Faculty. The supervisor of the candidate's thesis will usually, but not necessarily, be designated as chairman. At his discretion, the Dean may add other members to the committee.

The doctoral committee is responsible for establishing the broad outline of the student's program and should review the program as soon as possible after admission to candidacy. The committee will prepare, give, and evaluate the candidate's examinations, and supervise and approve his thesis. A favorable vote of at least two thirds of the members of the committee is required for passing a comprehensive or a final oral examination. If a candidate fails an examination, it is the responsibility of the doctoral committee to determine whether he may take another examination.

The committee will also notify the Dean when the candidate is ready to have his comprehensive and his final oral examination scheduled and will report the results of these examinations to the Dean.

**LANGUAGE EXAMINATIONS**—A candidate for the degree of Doctor of Philosophy is required to demonstrate high-level competence in the use of the English language, including reading, writing, listening, and speaking. Proficiency is expected at the time of admission to the Graduate School and must be achieved before admission to candidacy.

In addition to demonstrating competence in English, each candidate for the Ph.D. must show either a reading knowledge of two other languages or a reading, writing, listening, and speaking knowledge of one other language. The languages used to



## DOCTORAL DEGREES

satisfy this requirement must have significance in the candidate's field of study and be approved by the candidate's doctoral committee and the Dean of the Graduate School. French, German, and Russian are the languages most frequently needed and will be approved by the Dean without specific request. The use of any other language must be approved in advance.

When competence in two languages is offered in fulfillment of the requirements, the student is urged to complete one-half of the requirement before admission to candidacy and is required to complete the whole requirement before taking the comprehensive examination. If the candidate elects to demonstrate a reading, writing, listening, and speaking knowledge of one language, he is required to demonstrate competence in two of the four skills before admission to candidacy and in all four before taking the comprehensive examination.

Registration for both types of examination occurs at the beginning of the term, the specific date being given in the calendar. An applicant for an examination in reading competence is required to present himself to the language department concerned for a preliminary test in oral translation, not to exceed 15 minutes' duration during the registration period of one of the terms. A student who makes a very poor showing in the preliminary test will not be permitted to register for the next examination and may be required to take another preliminary test.

The examinations in reading competence are administered by the respective language departments and are held four times each year. Specific dates may be obtained from the calendar. The examination, which is to be written and to be completed with the aid of a dictionary, is one hour in length. The text for translation shall be a periodical article selected by the examining department from five articles in the candidate's field of specialty and recommended by his adviser or department head. Each of the articles recommended shall be not less than 500 words in length.

Administration of the examinations designed for demonstration of a reading, writing, listening, and speaking knowledge of a language other than English is vested in two members of each of the foreign language departments. Immediately upon registration the candidate is assigned by the examiners a work of considerable length unrelated to the area of his specialty; discussion of this work with the examiner six weeks later in the language in which it is written will serve to determine the candidate's broad, idiomatic grasp of the language. Subsequently, the candidate will be required without prior preparation to write in the same language a summary of the contents of a shorter document in the area of his specialty. For this purpose his adviser or department head is expected to recommend to the examiners five articles of at least 500 words in length, the titles of which are not known to the student, from which they will select the one to be employed. All arrangements for the examination are to be made in the language in which competence is to be demonstrated.

In general, the language requirements must be met at this University. However, if a student has passed suitable language proficiency examinations at another institution prior to admission to the Graduate School at Penn State, this may be accepted under certain circumstances in satisfaction of requirements here. A letter of certification from the Graduate Dean of the other institution will be required.

Candidates for the D.Ed. degree may be required by their major departments to demonstrate competency in foreign languages, but there is no Graduate School requirement.

**COMPREHENSIVE EXAMINATIONS**—A candidate for the Ph.D. or D.Ed. degree is required to take a comprehensive examination covering his major and minor fields to determine if he has adequate mastery of the subject matter to entitle him to proceed to the completion of a thesis.

This examination will normally be taken when the candidate has substantially completed his course work. It is officially scheduled and announced by the Dean of the Graduate School upon recommendation of the doctoral committee. In no

## DOCTORAL DEGREES

case may the final examination be scheduled less than three months after the comprehensive examination. The comprehensive examination is given and evaluated by the doctoral committee and may be either written or oral, or both. A favorable vote of at least two thirds of the members of the committee is required for passing. In case of failure, it is the responsibility of the doctoral committee to determine whether he may take another examination. The results are reported to the Dean of the Graduate School.

A candidate for the degree of Doctor of Philosophy must have satisfied the language requirements before taking the comprehensive examination.

**FINAL ORAL EXAMINATIONS**—The doctoral candidate who has satisfied all other requirements for the degree will be scheduled by the Dean of the Graduate School, on recommendation of the doctoral committee, to take a final examination. In no case may the final examination be scheduled less than three months after the comprehensive examination. The deadline for holding the examination is three weeks before Commencement.

The final examination is oral, open to the public, and related in large part to the thesis; but it may cover the whole field of study of the candidate without regard to courses that have been taken either here or elsewhere.

A favorable vote of at least two thirds of the members of the committee is required for passing. The results of the examination are reported to the Dean of the Graduate School and will be entered upon the candidate's official record. If a candidate fails, it is the responsibility of the doctoral committee to determine whether he may take another examination.

## PH.D.—ADDITIONAL SPECIFIC REQUIREMENTS

The degree of Doctor of Philosophy is conferred in recognition of high attainment and productive scholarship in some special field of learning as evidenced by (1) the satisfactory completion of a prescribed period of study and investigation, (2) the preparation of a thesis involving independent research, and (3) the successful passing of examinations covering both the special subject and the general field of learning of which this subject forms a part.

**MAJOR AND MINOR FIELDS**—Programs leading to the degree of Doctor of Philosophy are offered in a wide variety of fields. A program includes a major and either a minor or a group of general studies with approximately two thirds of the total time being devoted to the major field. A minor consists of no fewer than 15 credits, including those applied toward the master's degree, of integrated or articulated work in one field related to, but different from, that of the major. A general studies group consists of no fewer than 15 credits, including those applied toward the master's degree, in fields other than that designated as the major field and considered by the major department to have significance and value for the candidate.

**THESIS**—The ability to do independent research and competence in scholarly exposition must be demonstrated by the preparation of a thesis on some topic related to the major subject. It should represent a significant contribution to knowledge, be presented in a scholarly manner, reveal on the part of the candidate an ability to do independent research of high quality, and indicate considerable experience in using a variety of research techniques. The contents and conclusions of the thesis must be defended at the time of the final oral examination.

The completed thesis together with an abstract, typewritten in triplicate, must be filed in the office of the Dean of the Graduate School not later than two weeks prior to the commencement at which the candidate expects to receive the degree.

A *Thesis Information Bulletin*, which gives details concerning format, paper, illustrations, and other items, may be obtained at the Graduate School office.



## DOCTORAL DEGREES

### D.ED.—ADDITIONAL SPECIFIC REQUIREMENTS

Programs leading to the degree of Doctor of Education are not limited to specific fields of education but, with the consent of the department or committee in charge, may also be offered in any other field appropriate to the preparation of teachers which has been approved for the doctorate, such as biological science, foods and nutrition, or English.

The degree is conferred in recognition of advanced preparation of a high order for work in the profession of education as evidenced by (1) the satisfactory completion of a prescribed period of study; (2) ability to apply scientific principles in classroom instruction, supervision of instruction, administration, or as a consulting specialist in certain educational areas; (3) preparation of a thesis demonstrating ability to undertake an educational problem with originality and independent thought; and (4) successfully passing examinations showing a satisfactory grasp of the field of specialization and its relation to allied educational areas.

**MAJOR AND MINOR FIELDS**—The program of study includes a major and either a minor or a group of general studies. A majority of the courses offered in fulfillment of the requirements must be in the major field of study.

A candidate choosing a major outside the fields of education (such as speech, geography, or history) shall have a minor consisting of no fewer than 15 credits, including those applied toward the master's degree, in educational foundations, which includes the following specific courses in comparative education, educational measurements and statistics, educational psychology, history of education, and philosophy of education: Ed.Ser. 417, 418, 490, 494, 516, 517, 522, 590; and Psy. 414, 502, 513, 514.

A candidate choosing a major in one of the fields of education must also choose either a minor or a group of general studies with the approval of the major department. In this case a minor consists of no fewer than 15 credits, including those applied toward the master's degree, in one field outside the fields of education. An acceptable general studies group consists of no fewer than 15 credits, including those applied toward the master's degree, in fields outside the fields of education considered by the major department to have significance and value for the candidate.

**COMPREHENSIVE EXAMINATIONS**—In addition to demonstrating a high level of competence in the subject matter of his major and minor fields, each candidate must show in his comprehensive examination that he is familiar with current theories of education; that he understands and can apply the techniques and the findings of educational research so far as they bear upon the teaching of his subject; that he is prepared to read understandingly and contribute to the technical and professional literature in his field; and that he can criticize his own procedures in the light of historical trends and practices in this and other countries. Command of the tools for a thorough study of the problems of education is necessary and must include familiarity with statistical methods. For certain students the requirements may include a reading knowledge of one or more foreign languages.

**THESIS**—Evidence of a high degree of scholarship, competence in scholarly exposition, and ability to select, organize, and apply knowledge must be presented by the candidate in the form of a written thesis. The candidate must demonstrate a capacity for independent thought as well as ability and originality in the application of educational principles or in the development of new generalizations under scientific controls. The thesis may be based upon a product or project of a professional nature, provided that scholarly research is involved. For example, it may be based upon the solution of a professional problem concerned with the development of a curriculum, or a product of creative effort related to education. However, in order to be acceptable as a thesis, the professional project must be accompanied by a written discourse demonstrating the nature of the research and including such theories, experiments, and other rational processes as were used in effecting the final result.



## PROGRAMS AND COURSES

The topic and outline of the proposed thesis must have the approval of the doctoral committee.

The completed thesis together with an abstract, typewritten in triplicate, must be filed in the office of the Dean of the Graduate School not later than two weeks prior to the commencement at which the candidate expects to receive the degree.

A *Thesis Information Bulletin*, which gives details concerning format, paper, illustrations, and other items, may be obtained at the Graduate School office.

## PROGRAMS AND COURSES

Programs of study leading to advanced degrees are offered in many major and minor fields which are listed in the following section, and the major fields are summarized on page 54. Related courses are grouped together under the name of the field. To locate a particular course or group of courses, consult the index.

In general, departments of the University are identified with specific major fields. Thus aeronautical engineering is a major field of study which is offered under the supervision of the Department of Aeronautical Engineering. On the other hand, biological science and comparative literature are major fields for which there are no corresponding departments. In such cases a committee of the Graduate School is responsible for administering the program. In some cases a single department offers work in more than one field. Thus the Department of Civil Engineering offers work in both civil and sanitary engineering.

Applicants for admission are encouraged to consult the person whose name is listed under the major field heading.

**DEGREES**—In those major fields approved for the doctorate, the Ph.D. is normally conferred, although a program leading to the D.Ed. may also be arranged with the consent of the department or committee in charge if such a professional program is appropriate. Similarly, in major fields approved for the master's degree the M.A. or M.S. is normally conferred, but a program leading to the M.Agr., M.B.A., M.Ed., M.Eng., M.F., or M.P.A. may also be available. The D.Ed. and M.Ed. are not limited to the fields of education, but with the consent of the department or committee in charge may be offered in any approved major field appropriate to the preparation of teachers, such as mathematics or English. In this case the program is sponsored by a major department outside the fields of education, such as the Department of Mathematics, but the student's minor is in education.

**MINOR FIELDS**—All major fields listed are also acceptable as minors. In addition, a few fields in which no advanced degrees are offered have been approved as minors for candidates who are majoring in related areas. Such minor fields are identified in the summary on page 54 and by a brief statement under the field heading in the following section.

A candidate's choice of minor field depends upon the particular degree he is seeking and is subject to the approval of his major department. The requirements in each minor field are established by the minor department subject to the regulations of the Graduate Faculty.

**INTERDISCIPLINARY MAJORS**—In addition to the majors listed on page 54, interdisciplinary majors involving two or more departments may be arranged with the approval of the Dean of the Graduate School. These programs are offered under the supervision of appropriate interdepartmental committees.

**OTHER FIELDS**—Fields which have not been approved for either major or minor work, but in which approved courses are offered, are listed at the end of this

## PROGRAMS AND COURSES

bulletin. These courses may be used in graduate programs as electives or as part of a general studies program, subject to the approval of the major department and to the restrictions upon the use of 400 series courses in degree programs.

**COURSE NUMBERING SYSTEM**—Courses in the series 1-399 are not listed in this bulletin because they are strictly undergraduate courses and yield no graduate credit. A graduate student may register for or audit these courses in order to make up deficiencies or fill in gaps in his earlier education but not to meet requirements for an advanced degree.

Courses in the series 400-499 are for upperclassmen with at least junior standing and for graduate students. Only a limited number of credits earned in these courses may be counted toward the requirements for an advanced degree. Detailed regulations concerning the restrictions are given on pages 42 to 46 under the specific requirements for the various masters' degrees.

Courses in the series 500-599 are restricted to students registered in the Graduate School, seniors with an average of at least 3.5, and other students who have been granted permission to enroll by the Dean of the Graduate School.

Course numbers 600 and 610 apply to thesis research and are available only to students registered in the Graduate School.

**CREDITS**—A credit is defined as a unit of time approximately equivalent to one week of full-time graduate study. Accordingly, a full-time student having no concurrent employment may earn a maximum of 10 credits in a 10-week term. A "credit" as used in this bulletin, therefore, is identical in meaning with a "semester credit" and should not be confused with a "quarter credit" which is associated with the traditional quarter system. By increasing the length of class periods to 75 minutes, the current Penn State calendar based upon a 10-week term provides for the same amount of time in a given course as did the previous semester plan.

**COURSE DESCRIPTIONS**—A course abbreviation, a number, and a title designate each course. Course designations and official abbreviations are listed at the left-hand margin just above the first course in each group. The figures in parentheses following the course title show the number of credits which may be granted for that course. In the case of courses with variable credits, the number of credits which may be earned in a single term is determined by the department offering the course.

A department may schedule an entire section of a course below the 400 level for fewer credits than the maximum authorized. In 400 and 500 series courses a department may schedule an individual student for fewer credits than the maximum number but in no case for more than the maximum number authorized.

**SCHEDULE OF COURSES**—A complete list of the courses which will be offered in any specific term is given in the *Timetable*, which is available at nominal cost from the Scheduling Office approximately six months before the beginning of the term. It gives the number of credits being offered in each course, the hours at which the class will meet, the location of the class, and in some cases the instructor's name.

**RESEARCH AND THESIS WORK**—In general, students registering for work on a master's or a doctor's thesis will, if it is to be done on the University Park Campus, use course number 600 preceded by an abbreviation designating the major field. Thus Aro.E. 600 signifies thesis research in aeronautical engineering. In case such work has been authorized for students not working on the University Park Campus, the number 610 will be used. Credits will be 1 to 10 per term.

It should be assumed that the numbers 600 and 610 are available in all fields in which majors have been approved for advanced degrees although these numbers do not appear in the timetables.

MAJOR  
and  
MINOR  
FIELDS



## GRADUATE FIELDS OF STUDY

Aeronautical Engineering—Ph.D., M.S., M.Eng.	Geochemistry—Ph.D., M.S.
Agricultural and Biological Chemistry—Ph.D., M.S.	Geography—Ph.D., D.Ed., M.S., M.Ed.
Agricultural Economics—Ph.D., M.S., M.Agr.	Geology—Ph.D., M.S.
Agricultural Education—Ph.D., D.Ed., M.S., M.Ed.	Geophysics—Ph.D., M.S.
Agricultural Engineering—M.S.	German—Ph.D., M.A., M.Ed.
Agronomy—Ph.D., M.S., M.Agr.	Higher Education—D.Ed.
Animal Husbandry—Ph.D., M.S.	History—Ph.D., D.Ed., M.A., M.Ed.
Animal Nutrition—Ph.D., M.S.	Home Art (minor only)
Anthropology—M.A.	Home Economics Education—Ph.D., D.Ed., M.S., M.Ed.
Architectural Engineering—M.S.	Horticulture—Ph.D., M.S.
Architecture—M.S.	Industrial Arts Education—Ph.D., D.Ed., M.S., M.Ed.
Art—M.A.	Industrial Engineering—M.S., M.Eng.
Art Education—Ph.D., D.Ed., M.S., M.Ed.	Journalism—M.A.
Bacteriology—Ph.D., M.S.	Mathematics—Ph.D., D.Ed., M.A., M.Ed.
Biological Science—D.Ed., M.Ed.	Mechanical Engineering—Ph.D., M.S., M.Eng.
Biophysics—Ph.D., M.S.	Metallurgy—Ph.D., M.S.
Botany—Ph.D., M.S.	Meteorology—Ph.D., M.S.
Business Administration—Ph.D., M.S., M.B.A.	Mineral Economics—Ph.D., M.S.
Business Education—Ph.D., D.Ed., M.S., M.Ed.	Mineral Preparation—Ph.D., M.S.
Ceramic Technology—Ph.D., M.S.	Mineralogy and Petrology—Ph.D., M.S.
Chemical Engineering—Ph.D., M.S.	Mining Engineering—Ph.D., M.S.
Chemistry—Ph.D., M.S., M.Ed.	Music—M.A.
Child Development and Family Relationships—Ph.D., D.Ed., M.S., M.Ed.	Music Education—D.Ed., M.Ed.
Civil Engineering—Ph.D., M.S., M.Eng.	Nuclear Engineering—M.S., M.Eng.
Clinical Speech—Ph.D., D.Ed., M.S., M.Ed.	Nutrition in Public Health—M.S.
Clothing and Textiles—Ph.D., D.Ed., M.S., M.Ed.	Petroleum and Natural Gas Engineering—Ph.D., M.S.
Comparative Literature—Ph.D., M.A.	Philosophy—Ph.D., D.Ed., M.A., M.Ed.
Counseling in Education—Ph.D., D.Ed., M.S., M.Ed.	Physical Education—Ph.D., D.Ed., M.S., M.Ed.
Dairy Science—Ph.D., M.S.	Physical Science—D.Ed., M.Ed.
Earth Sciences—M.Ed.	Physics—Ph.D., M.S.
Economics—Ph.D., M.A.	Plant Pathology—Ph.D., M.S.
Educational Administration—Ph.D., D.Ed., M.S., M.Ed.	Political Science—Ph.D., M.A.
Electrical Engineering—Ph.D., M.S., M.Eng.	Poultry Science—Ph.D., M.S.
Elementary Education—Ph.D., D.Ed., M.S., M.Ed.	Psychology—Ph.D., D.Ed., M.S.
Engineering Mechanics—Ph.D., M.S., M.Eng.	Public Administration—M.P.A.
English—Ph.D., D.Ed., M.A., M.Ed.	Recreation Education—Ph.D., D.Ed., M.S., M.Ed.
Entomology—Ph.D., M.S.	Romance Languages and Literatures—Ph.D., M.A.
Extension Education—M.Agr., M.Ed.	Rural Sociology—Ph.D., M.S., M.Agr.
Family Economics and Home Management—Ph.D., D.Ed., M.S., M.Ed.	Sanitary Engineering—M.S., M.Eng.
Food Service and Housing Administration—M.S., M.Ed.	Secondary Education—Ph.D., D.Ed., M.S., M.Ed.
Foods and Nutrition—Ph.D., D.Ed., M.S., M.Ed.	Social Studies—M.Ed.
Forestry—M.S., M.F.	Sociology—Ph.D., M.A.
Fuel Technology—Ph.D., M.S.	Solid State Technology—Ph.D., M.S.
General Family Studies—Ph.D., D.Ed., M.S., M.Ed.	Speech—Ph.D., D.Ed., M.A., M.Ed.
Genetics and Breeding—Ph.D., M.S.	Statistics (minor only)
	Theatre Arts—M.A.
	Vocational Industrial Education—Ph.D., D.Ed., M.S., M.Ed.
	Wildlife Management—M.S.
	Zoology—Ph.D., M.S.

The degrees listed above are the ones normally conferred in each of the designated major fields. Additional professional degrees, including the M.Agr., M.Ed., and M.Eng., have been authorized in many cases and may be offered at the discretion of the department head and the Dean of the Graduate School. Thus, the M.Ed. has been authorized for all of the above fields in which a master's degree is conferred provided the field is appropriate to the preparation of teachers.

# Courses in Major and Minor Fields

## AERONAUTICAL ENGINEERING

GEORGE F. WISLICENUS, *Head of the Department*  
233 Hammond Building

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Professor Wislicenus; Associate Professors Lumley and McCormick.

Course work and research are available in the following areas: classical and modern hydro-, aero-, and gas-dynamics, including aerochemistry and magneto-hydrodynamics; structures; aeroelasticity; turbomachinery, advanced propulsion; low-speed flight.

The entering student must hold a bachelor's degree in science, mathematics, or engineering and must have completed undergraduate course work in fluid and solid mechanics and in intermediate mathematical analysis.

### AERONAUTICAL ENGINEERING (ARO E)

401a,b,c. AERONAUTICAL ENGINEERING PROJECTS (2-12)

402. PROPULSION SYSTEMS DESIGN (2)

404. AIRPLANE AND MISSILE DESIGN (2)

407. AERODYNAMICS OF V/STOL AIRCRAFT (3)

408. AERONAUTICAL AND ASTRONAUTICAL TURBOMACHINERY (3)

410. AIRCRAFT AND SPACE PROPULSION (3)

411. AEROELASTICITY (3)

412. AERODYNAMICS OF VISCOUS FLUIDS (3)

413. STABILITY AND CONTROL OF AIRCRAFT AND MISSILES (3)

414. ADVANCED GASDYNAMICS (3)

415. ADVANCED THEORETICAL FLUID DYNAMICS (3-6)

416-417. AEROSPACE UNDERGRADUATE THESIS (2 each)

418. AEROSPACE SYSTEMS ENGINEERING (3)

501. AIRPLANE STABILITY AND CONTROL (3) General analysis of longitudinal and lateral stability of airplanes; characteristics of flight control devices. Prerequisite: Aro.E. 413.

503. AIRPLANE PERFORMANCE (3) Methods of performance prediction and performance flight testing for high-speed aircraft and missiles. Prerequisite: Aro.E. 413.

504. ROTARY WING AIRCRAFT (3) Types of rotary wing aircraft; helicopter performance, stability, and control. Prerequisite: Aro.E. 407.

505. AEROELASTICITY (3) Vibrating systems with several degrees of freedom; analysis of flutter speed of an airplane wing considering bending, torsion, and aileron motions; other types of aircraft flutter. Prerequisite: E.Mch. 401 or Aro.E. 411.

506. AIRCRAFT STRUCTURES (3-9) Deflections of beams and trusses; statically indeterminate structures; shear-flow analysis and shearing deformations of multi-cell semi-monocoque structures; effects of discontinuities in wing and fuselage structures. Prerequisite: E.Mch. 408.



## AERONAUTICAL ENGINEERING

507. AIRCRAFT GAS TURBINES AND JET PROPULSION ENGINES (3) Types of jet propulsion installations, thermodynamic cycles, analysis of compressors, combustion chambers, and turbines. Prerequisite: Aro.E. 410.
510. AERODYNAMICS OF COMPRESSIBLE FLUIDS (3) One-dimensional motion, shock waves, flow in nozzles, two-dimensional flow, airfoil theory, Prandtl-Meyer flow, method of characteristics. Prerequisite: Aro.E. 3.
511. AERODYNAMICS OF A PERFECT FLUID (3) Euler's dynamic equations, complex potential, conformal transformation, thin airfoils, Biot-Savart law; Prandtl three-dimensional airfoil theory. Prerequisite: Aro.E. 2.
512. AERODYNAMICS OF A VISCOUS FLUID (3) Navier-Stokes equations, incompressible and compressible boundary layer theory, jet and wake problems, hydrodynamic stability, turbulence. Prerequisite: Aro.E. 412.
513. RESEARCH IN AERONAUTICAL ENGINEERING (1-10 per term) Investigation of a theoretical or experimental project in aeronautical engineering.
514. AERONAUTICAL ENGINEERING SEMINAR (1 per term) Current literature and special problems in aeronautical engineering.
515. AERODYNAMICS (3) Airflow, airplane performance. For students with undergraduate training in science or engineering curriculums other than aeronautical engineering.
516. SPECIAL TOPICS IN AIRCRAFT STRUCTURES (3-9)
519. FLUID DYNAMICS OF ROTATING MACHINERY (3-6) Prerequisite: Aro.E. 2.
520. SPECIAL TOPICS IN AERODYNAMICS (3-9)

## AGRICULTURAL AND BIOLOGICAL CHEMISTRY

HOWARD O. TRIEBOLD, *Head of the Department*  
109 Frear Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Althouse, Boucher, Clagett, Frear, Guerrant, Mallette, Pritham, Sullivan, and Triebold; Associate Professor Shigley; Assistant Professors Mumma and Payne.

Opportunities for research and graduate study are available in plant metabolism and photosynthesis, intermediary metabolism, nucleic acids, proteins, carbohydrates, lipides, enzymes, vitamins, animal nutrition, poultry nutrition, clinical chemistry, endocrinology, and pesticides.

Entering graduate students should have had at least one year's work in each of the following: general chemistry, analytical chemistry, organic chemistry, physical chemistry, and general physics. Mathematics through integral calculus is also required. Students with limited deficiencies in these subjects may be admitted but must make up such deficiencies concurrently with their graduate studies. Undergraduate courses in biology, biochemistry, and foreign languages will be helpful to the student but are not required for admission.

### AGRICULTURAL AND BIOLOGICAL CHEMISTRY (AB CH)

401. GENERAL BIOCHEMISTRY (4)

*Mr. Clagett*



# AGRICULTURAL AND BIOLOGICAL CHEMISTRY

402. GENERAL BIOCHEMISTRY (4) Mr. Clagett  
 403. DAIRY CHEMISTRY (3) Mr. Shigley  
 404. FOOD CHEMISTRY (4) Mr. Triebold  
 417. METHODS OF AGRICULTURAL ANALYSIS (4) Messrs. Triebold and Mumma  
 425. BIOPHYSICAL CHEMISTRY (4) Mr. Mumma  
 426. BIOCOLLOIDS (3) Mr. Mallette  
 436. PHYSIOLOGICAL CHEMISTRY (3) Mr. Pritham  
 437. PHYSIOLOGICAL CHEMISTRY (3) Mr. Pritham  
 438. CLINICAL METHODS (3) Mr. Pritham  
 439. PROBLEMS IN AGRICULTURAL CHEMISTRY (3-5)  
 440. PLANT BIOCHEMISTRY (3) Mr. Clagett
501. ENZYMES (2) Investigations and theories concerning nature of enzymes, enzyme action, influence of chemical environment on enzyme action, and biological applications. Prerequisite: A.B.Ch. 437. Fall term. Mr. Clagett
503. BIOCHEMICAL PROBLEMS (1-10 per term) Prosecution of an assigned problem under the guidance of an instructor.
505. VITAMINS AND DIETARY DEFICIENCY DISEASES (2) Lectures, conferences, and assigned reading. Prerequisite: A.B.Ch. 437. Fall term, odd years. Mr. Guerrant
506. VITAMIN ASSAY METHODS (2) Lectures, conferences, and demonstrations dealing with approved methods of vitamin assay including demonstrations of typical vitamin deficiency syndromes in the rat. Prerequisite: A.B.Ch. 505. Winter term, even years. Mr. Guerrant
- 507a. SEMINAR IN PHYSIOLOGICAL CHEMISTRY AND NUTRITION (1 per term)  
Messrs. Guerrant, Boucher, Pritham, and Payne
- 507b. SEMINAR IN FOODS AND ANALYTICAL CHEMISTRY (1 per term)  
Messrs. Triebold and Shigley
- 507c. SEMINAR IN PLANT, ENZYME, AND INSECTICIDE CHEMISTRY (1 per term)  
Messrs. Frear, Mallette, Clagett, and Mumma
508. BIOCHEMICAL LITERATURE (1-3) Assigned readings, reports, and conferences on selected topics in biochemistry. Prerequisite: A.B.Ch. 437.
510. PROTEINS, AMINO ACIDS, AND PEPTIDES (2) Organic, physical, and biological chemistry of the naturally occurring compounds of this group. Prerequisites: A.B.Ch. 425, 437. Fall term. Mr. Mallette
511. CARBOHYDRATES (2) Chemical constitution and properties of carbohydrates; their metabolism in plant and animal organisms. Prerequisite: A.B.Ch. 437. Spring term.
512. LIPIDES (2) Investigations on biochemistry of fats and related substances. Winter term. Mr. Shigley
516. CHEMISTRY OF THE PESTICIDES (2) Lectures and assigned readings on the chemistry of insecticides, fungicides, herbicides, rodenticides, and related materials. Prerequisite: Chem. 31 or A.B.Ch. 437. Winter term, even years. Mr. Frear
517. ENDOCRINE SECRETIONS (2) Chemistry of hormones and their physiological significance. Prerequisite: A.B.Ch. 437. Spring term, even years. Mr. Pritham
518. MINERAL METABOLISM (2) Utilization and function of mineral elements in animal nutrition. Prerequisite: A.B.Ch. 437. Spring term, odd years. Mr. Boucher

## AGRICULTURAL AND BIOLOGICAL CHEMISTRY

519. INTERMEDIARY METABOLISM (3) Processes involved in the utilization of metabolites in plants and animals. Prerequisite: A.B.Ch. 402. Spring term.  
*Mr. Mallette*
520. BIOCHEMICAL METHODS (3) Lectures and advanced laboratory on current techniques pertaining particularly to research on proteins and enzymes. Prerequisite or concurrent: A.B.Ch. 501, 510. Fall term. *Messrs. Clagett and Mallette*
521. BIOCHEMICAL METHODS (3) Lectures and advanced laboratory on current techniques pertaining particularly to research on lipides and carbohydrates. Prerequisite or concurrent: A.B.Ch. 511, 512. Winter term.  
*Messrs. Shigley and Mumma*

## AGRICULTURAL ECONOMICS

MACKLIN E. JOHN

*Head of the Department of Agricultural Economics and Rural Sociology*  
1 Weaver Building

*Degrees Conferred:* Ph.D., M.S., M.Agr.

*Graduate Faculty:* Professors Barr, Becker, Bennett, Brandow, Butz, Frey, Hutton, Pasto, Pierce, Southworth, and Trotter; Associate Professor McAlexander.

The entering student in the master's program should have as prerequisites 3 credits in agricultural economics, 3 credits in economics, and 3 additional credits in either agricultural economics or economics. If a student lacks some of the prerequisites, he may take them without graduate credit during the early part of his master's program.

### AGRICULTURAL ECONOMICS (AG EC)

407. ADVANCED FARM MANAGEMENT (3) *Mr. Hutton*
420. AGRICULTURAL PRICES (3) *Mr. Bennett*
421. LAND ECONOMICS (3) *Mr. Frey*
426. (A.H. 426) LIVESTOCK MARKETING (3) *Mr. Trotter*
500. SEMINAR IN AGRICULTURAL ECONOMICS (1-6) Review of current literature and problems.
503. RESEARCH METHODS IN FARM MANAGEMENT (1-3) Evaluation of research procedures, methods, results, and needs in the field; emphasis on their application to specific research problems. Prerequisites: Ag.Ec. 6, Econ. 14.
504. AGRICULTURAL PRICE AND INCOME POLICY (3) Analysis of farm prices, income consequences for producers and consumers, and effects on resource use; evaluation of policy, considerations in policy making. Prerequisites: Ag.Ec. 420, Econ. 405.  
*Mr. Brandow*
505. ADVANCED AGRICULTURAL STATISTICS (3) Multiple correlation, curve fitting, analysis of variance, selection of samples, and other techniques applicable to the rural social sciences. Prerequisite: 3 credits in statistics. *Mr. Bennett*
506. ECONOMIC PROBLEMS IN MARKETING SPECIFIC AGRICULTURAL PRODUCTS (3) Profit maximization; psychological and sociological aspects of selling; engineering aspects of cost reduction; techniques in developing information for managerial decisions.
507. SEMINAR IN FARM MANAGEMENT (1-6) Special problems relating to organization and operation of the farm business. Prerequisites: Ag.Ec. 6, Econ. 14.



## AGRICULTURAL ECONOMICS

510. ADVANCED FARM FINANCE (1-3) Problems and policies in agricultural credit, insurance, and farm financial management. *Mr. Hutton*
515. ECONOMIC PROBLEMS IN THE MARKETING OF DAIRY PRODUCTS (3) Economic problems as they are encountered in the process of marketing; particular attention to governmental regulation in pricing and marketing. *Mr. Pierce*
517. PROBLEMS AND POLICIES OF FARMER COOPERATIVES (3) Specific types of cooperative organizations, their problems, policies, and progress; relationships existing among cooperatives, between cooperatives and other business organizations, and between cooperatives and the public. Prerequisite: Ag.Ec. 17. *Mr. Becker*
520. FARM PRICE ANALYSIS (3) Econometric analysis of prices, production, and utilization of farm products; review of research in this field. Prerequisites: Ag.Ec. 420, 505; Econ. 405. *Mr. Brandow*
522. ADVANCED FARM APPRAISAL (2) Land value theory; methods of land valuation; field practice in farm appraisal. *Mr. Pasto*
525. RESEARCH METHODS IN RURAL SOCIAL SCIENCES (2) Scientific method in planning and conducting research. Prerequisite: 9 credits in social sciences.
526. RESEARCH METHODS IN AGRICULTURAL ECONOMICS (2) Application of economic and statistical principles.
534. AGRICULTURAL PRODUCTION ECONOMICS (3) Economic theory applied to agricultural production problems: resource combinations, firm size, uncertainty and expectations, aggregate aspects of production, technological change. *Mr. McAlexander*
535. SEMINAR IN AGRICULTURAL MARKETING (2) *Mr. Southworth*
536. SEMINAR IN DAIRY ECONOMICS (1 per term) *Messrs. Pierce and Butz*

## AGRICULTURAL EDUCATION

DAVID R. McCLAY, *Head of the Department*  
101 Agricultural Education Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors McClay and Stevens; Associate Professor Hoover.

The requirements for admission to graduate work in agricultural education are 18 credits in professional education courses including educational psychology and practice teaching in vocational agriculture, or certification to teach vocational agriculture. Students who lack any part of these requirements may be admitted but are required to fulfill deficiencies without degree credit.

Minors may be taken in any of the areas of agricultural technology, or, for Master of Science and Doctor of Philosophy degree candidates, in one of the other fields of education, such as educational administration or higher education.

### AGRICULTURAL EDUCATION (AG ED)

- 418v. SURVEY OF VOCATIONAL EDUCATION IN AGRICULTURE (1-3) *Mr. Hoover*
- 420v. ADVANCED VISUAL AND OTHER SENSORY AIDS IN TEACHING AGRICULTURE (1-6) *Mr. Anthony*
- 422v. SUPERVISION OF VOCATIONAL EDUCATION IN AGRICULTURE (1-3) *Mr. Anthony*



## AGRICULTURAL EDUCATION

- 424v. OCCUPATIONAL GUIDANCE IN AGRICULTURAL INDUSTRY (1-4) *Mr. Hoover*  
426v. YOUNG AND ADULT FARMER EDUCATION IN VOCATIONAL AGRICULTURE (1-4) *Mr. Stevens*  
434v. AGRICULTURAL DEVELOPMENTS (1-6) *Messrs. Love and Bristol*
- 501v. HISTORY OF AGRICULTURAL EDUCATION (1-3) Development of training for agricultural vocations; emphasis upon introduction of agricultural instruction into the high school program. *Mr. Hoover*
- 502v. TEACHING VOCATIONAL AGRICULTURE (1-3) Organization of instruction with respect to vocational objectives, methods of presentation, supervision of practice, pupil evaluation of goals, and follow-up. *Mr. Stevens*
- 503v. RESEARCH IN AGRICULTURAL EDUCATION (1-6 per term) Individual study problems in various phases of agricultural education, such as evaluation of teaching, teaching procedures, and teacher preparation. *Mr. Stevens*
- 504v. AGRICULTURAL EDUCATION SEMINAR (1 per term) *Mr. McClay and Staff*
- 508v. STATE AND COUNTY ADMINISTRATION AND SUPERVISION OF AGRICULTURAL EDUCATION (1-3) Organization and administration of state, county, township, and district systems of agricultural education; state and federal legislation. *Mr. McClay*
- 509v. TEACHER TRAINING IN AGRICULTURAL EDUCATION (1-6) Construction of college curriculums, courses of study, and organization of college departments for training agricultural teachers. *Mr. McClay*
- 520v. SCIENTIFIC METHOD IN THE STUDY OF AGRICULTURAL EDUCATION (1-4) Methods of procedure in investigation and experimentation in education, accompanied by a critical examination of studies made in agricultural education. *Mr. Stevens*
- 521v. SCIENTIFIC METHOD IN THE STUDY OF AGRICULTURAL EDUCATION (1-4) Continuation of Ag.Ed. 520v; emphasis upon statistical techniques for students' individual problems. *Mr. Stevens*
- 524v. ANNUAL PLAN OF WORK (1-3) Detailed study of the agricultural education needs of each student's community and outlining annual plans of work. *Mr. Hoover*
530. AGRICULTURAL COLLEGE TEACHING (3) Selection and organization of subject matter for specific courses, methods of learning, teaching devices, technique of teaching, and measurements of results of teaching. *Mr. McClay*

## AGRICULTURAL ENGINEERING

FRANK W. PEIKERT, *Head of the Department*  
204 Agricultural Engineering Building

*Degree Conferred:* M.S.

*Graduate Faculty:* Professor Peikert; Associate Professor Bartlett.

Specialization is offered in farm power and machinery, electric power and processing, soil and water conservation engineering, and farm structures.

Prerequisite to major work is the completion of an undergraduate engineering curriculum from a recognized department.

## AGRICULTURAL ENGINEERING

### AGRICULTURAL ENGINEERING (AG E)

- 400. AGRICULTURAL ENGINEERING PROBLEMS (1-7)
- 401. FARM MECHANICS FOR TEACHERS OF VOCATIONAL AGRICULTURE (1½-9)
- 402. FUNCTIONAL DESIGN OF FARM STRUCTURES (3)
- 404. FARM MACHINERY (3)
- 405. ADVANCED FARM ELECTRIFICATION (3)
- 406. ADVANCED DAIRY ENGINEERING (3)
- 407. SOIL WATER ENGINEERING (3)
- 410. FARM POWER (3)
- 420. SEMINAR (1)
  
- 500. ADVANCED ELECTRO-AGRICULTURE (1-6) Investigations in the application of electrical energy to processing, storing, and handling agricultural products. Seminar, written reports.
- 501. ADVANCED FARM MACHINERY (1-6) Application of agricultural engineering principles to design and operation of farm machinery. Prerequisite: Ag.E. 410.
- 502. FARM STRUCTURES PROBLEMS (1-6) Analysis of farm structures design problems.
- 507. PROBLEMS IN SOIL WATER ENGINEERING (1-6) Analysis of engineering problems relating to irrigation, drainage, or erosion control.
- 508. ADVANCED PROBLEMS IN FARM MECHANICS (1-15) Problems in farm shop practice and agricultural engineering related to the farm mechanics program of vocational education in agriculture. Prerequisites: Ag.E. 8, 14; or teaching experience in farm mechanics.
- 509. RESEARCH IN AGRICULTURAL ENGINEERING (1-4)
- 520. AGRICULTURAL ENGINEERING SEMINAR (1-3) Reports on research and special topics.

## AGRONOMY

HOWARD B. SPRAGUE, *Head of the Department*  
118 Tyson Building

*Degrees Conferred:* Ph.D., M.S., M.Agr.

*Graduate Faculty:* Professors Fortmann, Higbee, Hunter, Kardos, Matelski, Raleigh, Richer, H. B. Sprague, V. G. Sprague, and Washko; Associate Professors Cleveland, Duich, Marriott, Pfeifer, and Thomas; Assistant Professors Baker, Gorsline, Johnson, Marshall, McKee, and Starling.

Areas of specialization include soil chemistry; soil conservation; soil classification; soil fertility; soil mineralogy; soil physics; the breeding of corn, small grains, and forage plants; forage management; turf management; potato culture; tobacco culture; weed control; and ecology of crops and pastures. Facilities are available for X-ray diffraction, infrared and petrographic investigations of soils.

Prerequisites for major work in agronomy vary with the area of specialization, but basic courses in chemistry, mathematics, physics, and biological sciences are required. Students who lack some of the course prerequisites may be admitted but are required to take the prerequisite courses without degree credit.

# AGRONOMY

## AGRONOMY (AGRO)

411. BREEDING OF FIELD CROPS (3) *Mr. Thomas*
- 416a. SOIL CHARACTERIZATION AND CLASSIFICATION—LECTURE (4) *Mr. Higbee*
- 416b. SOIL CHARACTERIZATION AND CLASSIFICATION—PRACTICUM (1) *Mr. Higbee*
417. FOREST SOILS (3) *Mr. Matelski*
419. SOIL PROPERTIES (4) *Mr. Baker*
422. SOIL CONSERVATION (3) *Mr. Kardos*
423. PASTURE AND GRASSLAND MANAGEMENT (3) *Mr. Washko*
424. FERTILIZER TECHNOLOGY (3) *Mr. Marriott*
425. PRINCIPLES OF FIELD CROP PRODUCTION (3) *Messrs. Pfeifer and Gorsline*
431. SOIL FERTILITY AND MANAGEMENT (3) *Mr. Marriott*
438. PRINCIPLES OF WEED CONTROL (3) *Mr. Raleigh*
490. AGRONOMIC PROBLEMS (1-6) *Mr. Washko and Staff*
501. ADVANCED SOIL FERTILITY (4) Interpretation of fertility experiments and diagnosis of soil-plant relationships through field appraisal, analysis, and plant symptoms. Prerequisites: Agro. 431, Bot. 406. Winter term, odd years. *Mr. Hunter*
503. AGRONOMY SEMINAR (1) Weekly meeting where papers and discussions will be presented by students and staff members. *Mr. H. B. Sprague*
506. SOIL CHEMISTRY (4) Analyses of important chemical and biochemical reactions occurring in soils, conditions which control these reactions and their importance in soil genesis and plant growth; laboratory work in the more typical and significant analytical procedures; lectures, review of current literature, and practicum. Prerequisites: Agro. 419; A.B.Ch. 417 or Chem. 23. Spring term, even years. *Mr. Baker*
507. SOIL PHYSICS (4) Physical properties of the soil; factors affecting them; their measurements, evaluation, and influence in determination of soil productivity. Prerequisites: Agro. 419, Phys. 215, A.B.Ch. 425. Fall term, even years. *Mr. Kardos*
509. GENETICS OF CROP PLANTS (3) Inheritance in crop plants with particular reference to factor interaction, genetic aspects of linkage and crossing-over, quantitative inheritance, and heterosis. Prerequisite: Bot. (Zool.) 422. Fall term, even years. *Mr. Cleveland*
510. THE APPLICATION OF CYTOGENETICS TO PLANT BREEDING (3) Cytogenetics, including chromosome structure and behavior, chromosome alterations, polyploidy, interspecific hybridization and their applications to plant breeding. Prerequisite: Bot. (Zool.) 422. Fall term, odd years. *Mr. Cleveland*
512. FIELD PLOT TECHNIQUE (4) Ramifications of analysis of variance techniques; combining and analyzing data from several experiments; selection of valid error terms. Prerequisite: Math. 8 or Ag. 400. Fall term. *Mr. Starling*
516. HUMUS (2) Origin and chemical nature of soil organic matter, its importance in soil processes, and its decomposition. Prerequisites: Agro. 419, 431. Winter term, odd years. *Mr. Richer*
517. FARM CROPS ECOLOGY (3) Ecological factors affecting growth and development of farm crops with particular reference to effects of altered environment and management practices. Prerequisites: Agro. 28, Bot. 406. Winter term, even years. *Mr. McKee*
518. GROWTH AND MANAGEMENT OF FORAGE CROPS (3) Factors affecting growth and development of forage crops with particular reference to effects of environment, defoliation, and management practices. Prerequisites: Agro. 423, Bot. 406. Spring term, odd years. *Mr. McKee*



519. THE NATURE OF SOIL MINERALS (3) Modern methods for identification of the constituent minerals of soils and their relation to soil classification and agricultural practices. Prerequisites: Agro. 1, Chem. 13, G.Sc. 1. Winter term, even years.  
*Mr. Johnson*
545. THE APPLICATION OF STATISTICS TO FIELD EXPERIMENTS (4) Use of advanced experimental designs in planning, analyzing, and interpreting experiments; includes lattice designs, factorials, confounding, simple and multiple covariance techniques. Prerequisite: Agro. 512. Winter term.  
*Mr. Starling*
- \*550. AGRONOMIC PROBLEMS (1-12) Provides training in selected areas of agronomy by means of supervised investigations or studies.
582. SEMINAR IN THE BREEDING AND GENETICS OF FARM CROPS (1-8 per term)

## ANIMAL HUSBANDRY

RUSSELL C. MILLER

*Head of the Department of Animal Industry and Nutrition*  
202 Armsby Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Bortree, Henning, and Miller; Associate Professor Gobble.

A student may specialize in animal production, animal breeding, and meats. The prerequisite for major graduate work in animal husbandry is the completion of an undergraduate curriculum in animal husbandry or a related animal science area. Students who lack some of the course prerequisites may be admitted but are required to take the prerequisite courses without degree credit.

### ANIMAL HUSBANDRY (A H)

421. ADVANCED MEAT STUDIES (3)
423. ADVANCED LIVESTOCK SELECTION (2)
424. ANIMAL HUSBANDRY SEMINAR (1)
426. (Ag.Ec. 426) LIVESTOCK MARKETING (3)
431. ADVANCED MEAT SELECTION AND GRADING (2)
500. SEMINAR IN ANIMAL HUSBANDRY (1-6)
501. PEDIGREE STUDY (1-6) Research work in breed study history, and analytical study of breed pedigrees, and a complete survey of the herd, flock, or stud book.
502. RESEARCH IN MEATS (1-6 per term) Investigation of methods for handling, cutting, processing, freezing, and curing meat and meat products. Prerequisite: A.H. 421.
503. LIVESTOCK MANAGEMENT (3) Handling of purebred herds and flocks; relation of livestock breeders to the public and methods of developing purebred herds and flocks through careful breeding.
505. ADVANCED ANIMAL BREEDING (1-5) Special problems in animal genetics as applied to breeding and improvement of horses, cattle, sheep, and swine. Prerequisite: A.H. (D.Sc., P.H.) 322.

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\*Credits 1-6 per term.

## ANIMAL NUTRITION

### ANIMAL NUTRITION

RUSSELL C. MILLER

*Head of the Department of Animal Industry and Nutrition*  
202 Armsby Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Barron, Bratzler, and Miller.

For admission a student must have had A.Ntr. 401 and 402 or their equivalent and must have met the requirements for graduate work in agricultural and biological chemistry. Specialized training is offered in the area of energy metabolism. Candidates for this major select courses from a number of related fields.

#### ANIMAL NUTRITION (A NTR)

- 401. PHYSIOLOGY OF NUTRITION (3)
- 402. ENERGY AND PROTEIN METABOLISM (3)

*Mr. Barron*

*Mr. Barron*

### ANTHROPOLOGY

MACKLIN E. JOHN

*Head of the Department of Sociology and Anthropology*  
240 Sparks Building

*Degree Conferred:* M.A.

*Graduate Faculty:* Professors F. R. Matson and Mook; Associate Professors Baker, Dupree, and Sanders.

Undergraduate preparation for this field must include 12 credits in anthropology and archaeology or their equivalent and at least 6 credits in related sciences, with breadth of background preferably in the arts and sciences. With special permission exceptional students will be admitted provided they make up course deficiencies without graduate credit.

Sociology may be chosen as a minor field by students majoring in anthropology.

#### ANTHROPOLOGY (ANTHY)

- 401. PHYSICAL ANTHROPOLOGY: HUMAN EVOLUTION (3)
- 402. HUMAN ECOLOGY (3)
- 442. ANTHROPOLOGY OF THE NEW WORLD (3)
- 443. ANTHROPOLOGY OF THE OLD WORLD AND MIDDLE EAST (3-6)
- 445. PRIMITIVE SOCIETY (3)
- 448. ANTHROPOLOGICAL THEORY (3)
- 540. ANTHROPOLOGICAL THEORY (3) Theory used in culture-historical, sociological, and psychological interpretations.
- 541. RESEARCH METHODS IN ANTHROPOLOGY (3-6) Principles, techniques, and examples of both field and library research in anthropology. Students will prepare research plans for class discussion.

545. SEMINAR IN ANTHROPOLOGY (1-9) Critical analysis of research in selected areas of anthropology. Prerequisites: Anthy. 45, 445.

## ARCHAEOLOGY (ARCHY)

- 400-401. ARCHAEOLOGY OF THE NEAR EAST (3 each)  
403. ARCHAEOLOGY OF THE NEW WORLD (3)

## ARCHITECTURE and ARCHITECTURAL ENGINEERING

PHILIP F. HALLOCK, *Acting Head of the Department of Architecture*  
and

GIFFORD H. ALBRIGHT, *Head of the Department of Architectural Engineering*  
308 Sackett Building

*Degree Conferred: M.S.*

*Graduate Faculty:* Professors Hajjar, Hallock, and Richardson; Associate Professors Albright and Reis.

To enter graduate study in the field of architecture, a degree of Bachelor of Architecture, Bachelor of Science in Architecture, or Bachelor of Fine Arts in a five-year curriculum in architecture is required.

To enter graduate study in the field of architectural engineering, a degree of Bachelor of Architectural Engineering or Bachelor of Science in Architectural Engineering in a five-year curriculum is required.

## ARCHITECTURE (ARCH)

411. ADVANCED ARCHITECTURAL DESIGN (6)  
412. ADVANCED ARCHITECTURAL DESIGN AND THESIS (5)  
413. ADVANCED ARCHITECTURAL DESIGN AND THESIS (5)  
421. (A.A.H. 421) CONTEMPORARY ARCHITECTURE (3)

501. ARCHITECTURAL DESIGN (4-8) Problems in advanced planning and design, including study of group composition. Practicum and seminar.

502. ARCHITECTURAL RESEARCH (2-12) Prosecution of assigned problems under the guidance of an instructor.

503. ARCHITECTURAL HISTORY RESEARCH (3-12) Original research in architectural history. Seminar and written reports.  
*Mr. Dickson and Staff*

## ARCHITECTURAL ENGINEERING (A E)

401. ARCHITECTURAL ENGINEERING (3)  
402. ARCHITECTURAL ENGINEERING (4)  
403. ARCHITECTURAL ENGINEERING (3)  
430. ARCHITECTURAL ENGINEERING (3)  
431. ARCHITECTURAL ENGINEERING (3)  
432. ARCHITECTURAL ENGINEERING (4)  
433. ARCHITECTURAL ENGINEERING THESIS (2)  
434. ARCHITECTURAL ENGINEERING THESIS (2)



## ARCHITECTURAL ENGINEERING

435. ARCHITECTURAL ENGINEERING THESIS (3)  
441. INTEGRATION OF ARCHITECTURAL ENGINEERING SYSTEMS (3)  
442. RESEARCH IN ARCHITECTURAL ENGINEERING (1-6)  
445. ARCHITECTURAL ENGINEERING SEMINAR (1-6)  
451. FUNDAMENTALS OF NUCLEAR DEFENSE PLANNING AND DESIGN (3)  
464. ADVANCED ARCHITECTURAL ILLUMINATION SYSTEMS DESIGN (3)
502. ARCHITECTURAL ENGINEERING (3-8) Advanced structural design in steel and reinforced concrete. Lectures and class criticism. Practicum and seminar.  
*Mr. Richardson and Staff*
503. ARCHITECTURAL ENGINEERING (4-8) Continuation of A.E. 502 in which problems of wind bracing in tall buildings, rigid frames, and heavy-framed constructions are studied. Practicum and seminar.  
*Mr. Richardson and Staff*
504. ARCHITECTURAL ENGINEERING (4-8) Statically indeterminate stresses in steel and reinforced concrete buildings; area moment, slope deflection, and moment distribution methods. Recitation and seminar.  
*Mr. Richardson and Staff*
542. ADVANCED PROBLEMS AND RESEARCH IN ARCHITECTURAL ENGINEERING (2-12) Investigation, analysis, and preparation of comprehensive report on subject relating to special problems in architectural engineering systems. Prerequisite: graduate standing.
545. ARCHITECTURAL ENGINEERING SEMINAR (1-6) Current literature and special problems in architectural engineering; presentation of technical papers. Prerequisite: graduate standing.
551. ADVANCED NUCLEAR DEFENSE PLANNING AND DESIGN I (3) Weapons effects data; dynamic strength of materials and structural elements; dynamic design; architectural, structural, electrical, and mechanical requirements for shelters. Prerequisites: A.E. 4, 5, 451; E.Mch. 12.  
*Mr. Albright*
552. ADVANCED NUCLEAR DEFENSE PLANNING AND DESIGN II (3) Blast-resistant design of framed structures, shear wall structures, arches, domes, and underground structures; radiation shielding characteristics of building materials. Prerequisites: A.E. 431, 432, 551; Phys. 237.  
*Mr. Albright*
553. SELECTED PROBLEMS IN NUCLEAR DEFENSE RESEARCH (1-6) Prerequisite or concurrent: A.E. 451.  
*Mr. Albright*

## ART

JULES HELLER, *Dean of the College of Arts and Architecture*  
105 Sparks Building

*Degree Conferred:* M.A.

*Graduate Faculty:* Professors Dickson, Heller, Hyslop, Weisman, and Zoretich; Associate Professor Enggass; Assistant Professor Shobaken.

Students may specialize in studio work or in the history of art and architecture. For admission at least 18 credits of undergraduate work in art are required. The graduate program is contingent upon the student's undergraduate preparation. If an inadequacy exists, the student will be required to make up the deficiency without degree credit.

### ART (ART)

400. ADVANCED OIL PAINTING (3-12)

- 410. WATER-COLOR PAINTING: LANDSCAPE, STILL LIFE, AND FIGURE (3-9)
- 420. APPLIED DESIGN (3-9)
- 431. SCULPTURE (2-6)
- 440. PRINTMAKING (2-6)
- 490. LIFE DRAWING (3)
- 500. ART RESEARCH (2-6) Prosecution of assigned problems under the guidance of an instructor.
- 510. ADVANCED PAINTING (2-12)
- 531. ADVANCED SCULPTURE (2-12)
- 540. ADVANCED PRINTMAKING (2-12)

#### ART AND ARCHITECTURAL HISTORY (A A H)

- 403. STUDIES IN THE ARTS OF THE MIDDLE AGES (3)
- 409. MOVEMENTS IN CONTEMPORARY ART (3-6)
- 410. TASTE AND CRITICISM IN ART (3)
- 413. PROBLEMS IN ART HISTORY (3-6 per term)
- 421. (Arch. 421) CONTEMPORARY ARCHITECTURE (3)
- 448. HISTORY OF PRINTS AND DRAWINGS (3)
- 502. SEMINAR IN MEDIEVAL ART (3-6) Original research into problems dealing with the art of the middle ages.
- 503. ART HISTORY RESEARCH (3-6) Original investigation in art history, to be pursued independently or concurrently with course work in particular fields.
- 504. SEMINAR IN RENAISSANCE ART (3-6) Investigations in the area of Renaissance art, centering around major masters and monuments.
- 505. SEMINAR IN BAROQUE ART (3-6) Investigations in the area of Baroque art centering around major masters and monuments.
- 506. SEMINAR IN MODERN ART (3-6) Lectures, readings, reports, and discussions in the field of modern art.
- 508. SEMINAR IN AMERICAN ART (3-6) Studies in the field of American art involving original research.

#### ART—MUSIC—THEATRE (A M T)

- 400. CONTEMPORARY FORMS IN ART, MUSIC, THEATRE I (3)
- 401. CONTEMPORARY FORMS IN ART, MUSIC, THEATRE II (3)

### ART EDUCATION

EDWARD L. MATTIL, *Head of the Department*  
269 Chambers Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Beittel and Mattil; Associate Professors Cataldo, Chomicky, Edmonston, and Pappas.

Graduate programs in this field prepare students for careers in public school art teaching, art supervision, college teaching, or research. To be admitted without deficiencies, the student is expected to have completed either a baccalaureate program

## ART EDUCATION

in art education or a program leading to certification. Such a program would include work in art studio, art history, art education, education, and psychology. Deficiencies may be made up by course work which is not counted as credit toward an advanced degree.

All students are expected to complete one year of teaching before receiving the master's degree and two years of teaching before receiving the doctor's degree.

### ART EDUCATION (A ED)

- 404. METHODS OF GRAPHICS AND ILLUSTRATIONS (3)
- 414. ADVANCED CRAFTS FOR TEACHERS (3-6)
- 420. CERAMICS FOR TEACHERS (3)
- 434. ART APPRECIATION IN THE EDUCATIONAL PROGRAM (3)
- 435. ART IN THE ELEMENTARY SCHOOL (3)
- 436. ART IN THE SECONDARY SCHOOL (3)
- 486. CURRENT PROBLEMS IN ART EDUCATION (2-3)
- 487. MURAL PAINTING IN SCHOOLS (3)
- 488. ADVANCED MURAL PAINTING IN SCHOOLS (3)
- 489. ART EXPERIENCES WITH CHILDREN (3)
  
- 501. SEMINAR IN ART EDUCATION (1-6) The analysis of fundamental concepts derived from related disciplines; the examination of current problems; current literature.
  
- 504. ADVANCED METHODS IN GRAPHIC PROCESSES (3) Exploration through laboratory experience of printing method: etching, silk screen, linoleum, or other; applications in teaching.
  
- 514. FUNCTIONAL RELATIONSHIPS IN CRAFTS (3) Relationships of material design and purpose in crafts discussed by means of outstanding products of different materials, periods, and cultures. Prerequisite: 6 credits in crafts or 3 in design and 3 in advanced crafts.
  
- 516. ANALYSIS OF THREE-DIMENSIONAL PROCESSES IN ART (3) Three-dimensional processes analyzed with regard to kinetic, textural, form, and other functions.
  
- 520. ADVANCED CERAMIC ART (3) Intensified exploration of throwing, glazing, and firing processes as related to aesthetic considerations in contemporary art forms and past cultures. Prerequisite: A.Ed. 420.
  
- 534. CREATIVE ART ACTIVITY FOR THE HANDICAPPED (3) Specific methods for development of creative art activity with the physically, mentally, emotionally, and socially handicapped; adjustive effect upon them. Prerequisite: 6 credits in art education or 6 in special education or 6 in psychology.
  
- 535. ADMINISTRATION AND SUPERVISION OF ART EDUCATION PROGRAMS (3) The problems and responsibilities of the city, county, and state art supervisor; curriculum, facilities, financing, supervision, in-service training, and reporting. Prerequisites: A.Ed. 435, 436.
  
- 588. HISTORY OF ART EDUCATION (3) Historical development of philosophies in art education in the United States and abroad.
  
- 598. RESEARCH METHODS IN ART EDUCATION (3-6) Orientation in research methods; findings and designs related to the study of problems in art education.
  
- 599. RESEARCH IN ART EDUCATION (1-6) Independent research, under an adviser, to be terminated by a scholarly report proportionately comparable in quality to a master's thesis. Prerequisite: 15 credits in art education on the 400 and 500 level, including A.Ed. 598.



## BACTERIOLOGY

ROBERT W. STONE, *Head of the Department*  
204 Patterson Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Cone, Dunne, Ludwig, Reid, and Stone; Associate Professors Casida, Gentry, Heist, Lindstrom, and Zimmerman; Assistant Professor Kinsloe.

Specialized areas of study include bacterial physiology, soil microbiology, food and industrial microbiology, immunology, and virology. There is opportunity for research in animal disease in cooperation with the Department of Veterinary Science.

**Prerequisites for admission** are 20 credits in chemistry including quantitative analysis and organic chemistry, and 20 in biological science including 8 in microbiology. It is possible to substitute additional chemistry credits for part of the biology requirement.

## BACTERIOLOGY (BACT)

- 401. GENERAL MICROBIOLOGY (4)
- 407. BACTERIOLOGY PROBLEMS (2-9)
- 410. IMMUNOLOGY AND SEROLOGY (4)
- 411. BACTERIOLOGICAL SURVEY (1)
- 412. ADVANCED BACTERIOLOGY (4)
- 413. SOIL MICROBIOLOGY (4)
- 414. FOOD MICROBIOLOGY (4)
- 416. INDUSTRIAL MICROBIOLOGY (4)
- 507. SEMINAR (1 per term) Reports on current fields of research.
- 508. PHYSIOLOGY OF BACTERIA (2-4) Composition, nutrition, and growth of microorganisms; influence of physical and chemical environment on metabolism.
- 509. FERMENTATION (2) Chemical activities of microorganisms; mechanisms of fermentative and oxidative metabolism.
- 510. LABORATORY IN FERMENTATION (2) Laboratory procedures and problems in fermentation to accompany Bact. 509.
- 512. BACTERIOLOGICAL TECHNIQUES (1-6) Practice in special laboratory techniques including manometry, tissue culture, and serology.
- 515. (V.Sc. 515) VIROLOGY (2-4) Rickettsial and viral agents parasitizing man, animals, and microorganisms. Prerequisite: Bact. 410.
- 516. BACTERIAL GENETICS (2-4) Mechanisms of variation in microorganisms including mutation, adaptation, sexual recombination, transduction, and transforming factors. Prerequisite: 3 credits each in bacteriology and genetics.

## BIOLOGICAL SCIENCE

LEON R. KNEEBONE, *Chairman of the Committee on Biological Science*  
117 Buckhout Laboratory

*Degrees Conferred:* D.Ed., M.Ed.

## BIOLOGICAL SCIENCE

The program in biological science is designed primarily to meet the needs of secondary school science teachers. The academic degrees M.S. and Ph.D. are not offered in biological science but are available in agricultural and biological chemistry, bacteriology, botany, entomology, genetics and breeding, plant pathology, and zoology.

In order to enter a program for a higher degree with a major in biological science, the candidate should present 30 credits in the natural sciences, including at least one year of chemistry, and 18 credits in education, including educational psychology and practice teaching. As many as 6 credits may be made up as undergraduate deficiencies after the candidate is admitted to the Graduate School.

The candidate for the M.Ed. degree must take at least 24 credits in the biological and physical sciences with a minimum of 15 credits in the biological sciences, including at least 6 in the animal sciences and 6 in the plant sciences. In addition, at least 6 credits in educational foundations and a term paper are required.

A reading knowledge of one foreign language is required for the D.Ed. degree.

## BIOPHYSICS

ERNEST C. POLLARD

*Chairman of the Committee on Biophysics*  
101 Walker Laboratory

*Degrees Conferred:* Ph.D., M.S.

This program is designed for those interested in applying physical methods to the problems of living systems. A student with a degree in physics, biology, chemistry, or engineering is eligible for admission. Opportunity to make up possible undergraduate deficiencies is provided in the program.

Courses are offered in molecular biophysics (an introductory course), nucleic acids, radiation action, cellular physiology, biophysical instrumentation, general biophysics, physics of viruses, and physics of the cell. Advice on the selection of other courses to meet the needs of each student is provided by a committee. These include courses in physics, chemistry, biochemistry, zoology, and bacteriology.

Theses may be supervised by faculty members of several departments who have competence in biophysics.

## BOTANY

ALVIN R. GROVE

*Acting Head of the Department of Botany and Plant Pathology*  
206 Buckhout Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Fergus, Grove, Kneebone, Wahl, and Wright; Associate Professors Grun, Hill, and Kovar; Assistant Professors Bell, Hamilton, Hillson, and Hovin.

The student may specialize in plant anatomy, cytology, ecology, genetics, morphology, mycology, physiology, plant pathology, or taxonomy. An entering student should present 27 credits of undergraduate work in botany or 21 credits in botany and 6 in biological science. As many as 6 credits may be made up as undergraduate deficiencies after the candidate has been admitted to the Graduate School.

In addition to its excellent facilities for research in various phases of botany, genetics, and plant pathology, the department is equipped with a Gamma Radiation Laboratory for the study of irradiation effects upon plants and other facets of radiation biology.

See also "*Plant Pathology*" and "*Genetics and Breeding*."

# BOTANY (BOT)

400. COMPARATIVE PLANT MORPHOLOGY (4) Mr. Hillson
405. (Zool. 405) GENERAL CYTOLOGY (3) Mr. Grun
406. PLANT PHYSIOLOGY (4) Mr. Bell
407. PLANT ANATOMY (3) Mr. Hillson
409. PLANT ECOLOGY (3) Mr. Kovar
414. TAXONOMY OF VASCULAR PLANTS (3) Mr. Wahl
419. (P.Path. 419) MYCOLOGY (3) Mr. Fergus
421. BOTANICAL TECHNIQUE (3) Mr. Grove
422. (Zool. 422) ADVANCED GENETICS (3) Messrs. Wright, Grun, and Nash
424. (W.U. 424) COMMERCIAL TROPICAL WOODS (3)
433. (Zool. 433) GENETICS, EUGENICS, AND EVOLUTION FOR TEACHERS (3) Messrs. Wright and Grun
500. PLANT PHYSIOLOGY SEMINAR (1 per term) Selected topics from recent literature; staff and student reports on current research. Winter term. Mr. Bell
501. THE PHYSIOLOGY OF THE FUNGI (3) Chemical composition, metabolism, toxic and stimulating agencies, spore germination, growth and irritability of the fungi. Prerequisites: Bot. 406, Bot. (P.Path.) 419, and preferably Chem. 32. Winter term, odd years. Mr. Fergus
505. (Zool. 505) CYTOLOGY AND CYTOGENETICS (3) Chromosome mechanism of heredity; relationship between plant and animal evolution and breeding and changes in chromosomes; cytological and cytochemical techniques. Prerequisite: Bot. (Zool.) 405 or 422. Spring term, odd years. Mr. Grun
506. COMPARATIVE ANATOMY OF VASCULAR PLANTS (3) Structure of the Tracheophyta from a phylogenetic standpoint. Prerequisite: Bot. 407. Spring term, even years. Mr. Hillson
511. ADVANCED PLANT PHYSIOLOGY (3) Physiology of plants including energy relations, synthesis, and metabolism. Prerequisite: Bot. 406. Fall term, odd years. Mr. Hamilton
512. ADVANCED PLANT PHYSIOLOGY (3) Continuation of Bot. 511. Physiology of plants including nutrition, growth, and development. Prerequisite: Bot. 406. Winter term, even years. Mr. Hamilton
516. ECOLOGICAL PLANT GEOGRAPHY (3) Distribution of plant communities; environmental factors which influence their present distribution; geological-historical development of plant communities, their past distribution. Prerequisite: Bot. 409. Winter term, odd years. Mr. Kovar
518. (P.Path. 518) SPECIAL PROBLEMS (1-12) The prosecution of an assigned problem under the guidance of a staff member. Throughout the year as arranged. By appointment.
521. MOLDS, YEASTS, AND ACTINOMYCETES (3) Morphology and taxonomy of fungi important in microbiology; identification and techniques of study. Fall term, odd years. Mr. Fergus



## BOTANY

522. (P.Path. 522) MYXOMYCETES, PHYCOMYCETES, AND ASCOMYCETES (4) Morphology, taxonomy, phylogeny, and life histories; identification and field work. Prerequisite: Bot. (P.Path.) 419. Winter term, even years. *Mr. Fergus*
523. (P.Path. 523) BASIDIOMYCETES AND FUNGI IMPERFECTI (4) Morphology, taxonomy, phylogeny, and life histories. Prerequisite: Bot. (P.Path.) 419. Spring term, even years. *Mr. Fergus*
524. (Zool. 524) SEMINAR IN GENETICS (1 per term) *Messrs. Wright and Grun*
525. STRUCTURE OF ECONOMIC PLANTS (3) Developmental and reproductive features of field and vegetable crops. Fall term, odd years. *Mr. Grove*
- 527a,b. PLANT BIOLOGY FOR TEACHERS (3 each) (a) Structure and physiology; (b) reproduction processes, development and relationships of plant groups. Methods of obtaining materials and setting up experiments. Designed for teachers and prospective teachers. Prerequisite: general biology or general botany courses. Summer term only; a and b given in alternate years. Bot. 527a must be taken before 527b. Accepted by the Department of Botany and Plant Pathology only for the M.Ed. and D.Ed. degrees. *Mr. Westerfeld*
528. (Zool. 528) POPULATION GENETICS (3) Factors affecting gene frequency, genotype frequency, genotype-environmental interaction, and genetic relationship in natural and artificial populations. Winter term, even years.
532. ADVANCED SYSTEMATIC BOTANY (2) Taxonomic principles including taxon concepts and criteria, nomenclature, classificatory systems, geographic distribution, speciation, and taxonomic literatures. Prerequisite: Bot. 14 or 414. Winter term, even years. *Mr. Wahl*
533. (Zool. 533) PROBLEMS IN GENETICS (2-6) Problems to suit needs of individual students; conferences and laboratory work. Prerequisite: Bot. (Zool.) 422. *Messrs. Wright and Grun*
534. MORPHOLOGY OF MARINE AND FRESH-WATER NONVASCULAR PLANTS (4) Classification, structure, development, and phylogenetic relationships of algae, liverworts, and mosses. Prerequisite: Bot. 421. Spring term, odd years. *Mr. Hillson*
535. MORPHOLOGY OF THE TRACHEOPHYTES EXCLUSIVE OF ANGIOSPERMS (3) Origin, developmental tendencies, structure, and paleobotanical evidence. Winter term, odd years. *Mr. Grove*
536. MORPHOLOGY OF ANGIOSPERMS (3) Floral origin and development, fertilization, embryogeny, seed and fruit development. Spring term, odd years. *Mr. Grove*
537. (Sec.Ed. 537, Zool. 537) WORKSHOP IN THE BIOLOGICAL SCIENCES (3) Projects designed for teachers of biology in the secondary schools. Summer term only.
538. BOTANY SEMINAR (1 per term) Presentation and discussion of selected topics.

## BUSINESS ADMINISTRATION

ROBERT D. PASHEK

*In Charge of Graduate Programs in Business Administration*  
122 Boucke Building

*Degrees Conferred:* Ph.D., M.S., M.B.A.

*Graduate Faculty:* Professors Bradley, Colwell, Cook, Hexner, Kniffin, McKinley, G. K. Nelson, Pashek, Richards, Saylor, Schrader, Strong, Waters, and Wherry; Asso-

## BUSINESS ADMINISTRATION

ciate Professors Babione, Beik, Carzo, Clewett, Ferrara, Greenlaw, Kautz, Phalan, Sauerlender, and Sussman; Assistant Professors Iwand and Williams.

The M.B.A. program is designed for those desiring professional training in business administration, regardless of their undergraduate background, in preparation for a career in either business or teaching. An applicant with little or no training in business administration may be admitted to the M.B.A. program and may schedule necessary preparatory courses while pursuing the graduate program. Three credits are required as preparatory courses in each of the following: accounting, business law, business statistics, economics, finance, management, and marketing.

The M.S. and Ph.D. degrees with a major in business administration are designed for those interested primarily in research and teaching.

For admission to these programs, a minimum of 18 acceptable undergraduate credits in the fields of accounting, commerce, economics, and business statistics—including at least 6 in economics and 3 in business statistics—is required. An applicant may be admitted with slight specific deficiencies which must be made up without degree credit.

Applicants for the various graduate programs in business administration are required to take the Admission Test for Graduate Study in Business given by the Educational Testing Service and used by leading graduate business schools throughout the country to supplement other criteria for admission. Candidates are strongly urged to take the test at the earliest possible date. The test will be given at University Park and at numerous locations in most states and foreign countries in November, February, April, and July. For dates and locations see the *Bulletin of Information*, Admission Test for Graduate Study in Business, published by the Educational Testing Service, 20 Nassau Street, Princeton, New Jersey. Applicants should read the bulletin carefully. All arrangements for taking the test must be made directly with the Educational Testing Service.

### ACCOUNTING (ACCTG)

- 401. ADVANCED ACCOUNTING (3)
- 403. ADVANCED AUDITING (3-9)
- 404. COST AND BUDGETARY CONTROL (3)
- 406. ADVANCED FEDERAL TAX ACCOUNTING (3)
- 407. CONTEMPORARY ISSUES IN ACCOUNTING (3)
- 408. GOVERNMENTAL ACCOUNTING (3)
- 409. MACHINE AND ELECTRONIC ACCOUNTING METHODS (3)
- 500. ACCOUNTING SEMINAR (3-6)
- 502. MANAGERIAL ACCOUNTING (3-6) Accounting techniques as control devices in business and industry; the use of quantitative data for policy decisions.
- 511. INTERPRETATION OF ACCOUNT DATA (3)
- 520. PROBLEMS IN ACCOUNTING (3-6) Planned individual projects involving library, laboratory, or field work.

### COMMERCE (COM)

- 406. INVESTMENT ANALYSIS (3)
- 408. CASE STUDIES IN BANKING AND FINANCE (3)
- 418. ESTATE PLANNING (3)
- 424. MARKETING RESEARCH (3)
- 427. RETAIL BUYING AND MERCHANDISING (3)
- 461. REGULATION OF TRANSPORT CARRIERS (3)



## BUSINESS ADMINISTRATION

462. PROBLEMS IN TRADE AND TRANSPORTATION (3)  
491. URBAN LAND UTILIZATION (3)
500. CASE STUDIES IN BUSINESS ADMINISTRATION (3) Case studies of business and management policy with respect to procurement, production, selling, finance, accounting, relations with government, labor, and the public.
501. COMMERCE SEMINAR (3-6) Reports on research in selected fields of commercial activities.
502. SEMINAR IN BUSINESS MANAGEMENT (3-6)
503. TRANSPORTATION AND PUBLIC UTILITY SEMINAR (3-6)
504. PROBLEMS IN COMMERCE (3-6) Planned individual projects involving library, laboratory, or field work.
506. SEMINAR IN INVESTMENTS AND CORPORATION FINANCE (3-6)
517. INTERNATIONAL BUSINESS PRACTICES (3) Practices of exporters and importers dealing in commodities traded in world markets under competition, monopoly, or governmental control. Prerequisite: Com. 162.
523. SEMINAR IN MARKETING (3-6) Research in modern marketing trends.
525. CASE STUDIES IN INSURANCE (3-6) Analysis of management's insurance problems, such as the feasibility of self-insurance; proper allocation of insurance premiums and coverage in selected industries, etc. Prerequisites: Com. 180, 280.
536. SALES MANAGEMENT SEMINAR (3) Principles of sales planning and administration; coordination of selling with advertising, promotion, production, and accounting; use of market research selling costs and budgets.
574. BUSINESS RESEARCH (1-3) A project paper, comparable in quality and scope of work to a graduate thesis, on problems of a company. Prerequisite: 15 credits of 400 and 500 courses in business administration.
577. ADMINISTRATIVE INTEGRATION (3) An analysis of coordination of the functional areas of business in relation to overall company objectives. Prerequisite: 15 credits of 400 and 500 courses in business administration.

## MANAGEMENT (MGMT)

430. ADMINISTRATIVE MANAGEMENT (3)  
435. CASES IN PUBLIC RELATIONS (3)

## BUSINESS EDUCATION

F. WAYNE HOUSE  
*In Charge of Graduate Programs in Business Education*  
243 Chambers Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

This program provides advanced preparation for teachers of business subjects for secondary schools and colleges. The subject-matter areas encompass secretarial, accounting, retailing, clerical, and general business sequences. The program may be adapted for the preparation of supervisors of business education.



A minimum of 18 acceptable undergraduate credits in education and psychology plus a minimum of 30 credits in business and business education subjects are required for admission.

All candidates specializing in business education are encouraged to acquire a general education in the social sciences, the behavioral sciences, and the humanities.

The following courses in business education are described on page 161 under the heading Secondary Education: Sec.Ed. 456, 459, 460, 461, 462, 463, 466, 467, 468, 511, 575, 576, 577, and 578.

## CERAMIC TECHNOLOGY

G. W. BRINDLEY, *Head of the Department*  
214 Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Brindley, Buessem, and Hummel; Associate Professors Stubican, Williamson, and Rindone.

The background for admission is a bachelor's degree in ceramics or in one of the related physical sciences. A knowledge of differential and integral calculus is required together with adequate physics and chemistry.

In view of the wide field covered by ceramic technology, the graduate courses may be selected with a bias toward physical ceramics, chemical ceramics, or glass technology. This makes it easily possible for students whose major subject for the bachelor's or master's degree has been either physics or chemistry to take appropriate graduate studies in ceramic technology.

Special facilities exist for research in the areas of clay mineralogy, phase diagram and related studies, ferrite and ferroelectric studies, glass technology, and high temperature reaction kinetics.

### CERAMIC TECHNOLOGY (CER T)

400. CRYSTAL CHEMISTRY OF CERAMIC MATERIALS (2)	Mr. Brindley
401. CERAMIC BODIES AND GLAZES (2)	Mr. Hummel
402. PRINCIPLES OF CERAMIC ENGINEERING (3)	Mr. Williamson
404. CERAMIC SEMINAR (1)	Mr. Hummel
405. CERAMIC RESEARCH AND DESIGN (1)	
406. RHEOLOGY AND FLUID PROPERTIES OF CERAMIC SYSTEMS (2)	Mr. Williamson
407. CERAMIC MATERIALS LABORATORY (2)	Mr. Williamson
408. HEAT TREATMENT OF CERAMIC MATERIALS (1)	Mr. Stubican
409. HEAT TREATMENT LABORATORY (2)	Mr. Stubican
410. PHASE RELATIONS IN CERAMIC SYSTEMS (3)	Mr. Hummel
411. PRINCIPLES OF CERAMIC PROCESSES (2)	Mr. Buessem
412. SURFACE CHEMISTRY OF CERAMIC MATERIALS (1)	Mr. Weyl
415. PRINCIPLES OF GLASS TECHNOLOGY (3-4)	Mr. Rindone
420. REFRACTORIES (2-3)	Mr. Stubican
425. CERAMIC RESEARCH AND DESIGN (2)	
430. ELECTROCERAMICS (1)	Mr. Buessem
451. WHITEWARES LABORATORY (1)	
452. ELECTROCERAMICS LABORATORY (1)	

## CERAMIC TECHNOLOGY

500. SEMINAR IN CERAMIC TECHNOLOGY (1-2 per term) Current developments in ceramic technology and related fields. Required of all graduate students in ceramic technology. *Mr. Brindley and Staff*
501. COLLOIDAL BEHAVIOR OF CLAYS AND MUDS (2-4) Colloidal properties of ceramic clays, glazes, drilling muds, filtering and bleaching clays, and kindred systems. *Mr. Williamson*
503. USE OF PHASE EQUILIBRIA DATA IN CERAMIC TECHNOLOGY (2-5) Phase equilibria in unary, binary, ternary, and other systems; applications in product development and in understanding behavior of ceramic materials. *Mr. Hummel*
504. SOLID STATE REACTIONS IN CERAMIC SYSTEMS (2) Thermodynamic, kinetic, and structural study of reactions and of equilibrium in ceramic systems. Prerequisites: Chem. 451, 452. *Mr. Brindley*
506. MECHANICAL PROPERTIES OF CERAMIC MATERIALS (2-3) Experimental stress-strain-time relations in elasticity, anelasticity, plasticity, and rupture; theory of strength and control. *Mr. Buessem*
507. THERMAL PROPERTIES OF CERAMIC MATERIALS (2-3) Heat capacity, heat of fusion, thermal conductivity, and thermal expansion in relation to macroscopic measurements and basic atomic concepts applied to ceramic materials. *Mr. Stubican*
508. DIELECTRIC AND MAGNETIC PROPERTIES OF CERAMIC MATERIALS (2-3) Preparation and properties of ceramic semiconductors, dielectrics, and magnetic materials. *Mr. Buessem*
510. SEMINAR IN GLASS TECHNOLOGY (1-2 per term) Current developments in glass technology and related fields. *Mr. Rindone*
511. CHEMICAL ASPECTS OF THE CONSTITUTION OF GLASS (1-3 per term) Historical development, properties, and atomistic interpretation of changes of properties with compositions, temperature, and past history. *Mr. Weyl*
512. PHYSICAL ASPECTS OF THE CONSTITUTION OF GLASS (1-3) Atomic structure of glass, its relation to physical properties; rheology; glass as a liquid. *Mr. Brindley*
515. SPECIAL PROBLEMS IN CERAMIC TECHNOLOGY (1-6 per term) Advanced individual study on a problem in ceramics.
516. SELECTED TOPICS IN CERAMIC TECHNOLOGY (1-3 per term) Intensive group study of special topics.
517. RESEARCH INSTRUMENTS AND EQUIPMENT (2) Applications of fundamental laws and principles in research instruments; care, adjustment, and effective use of instruments and equipment (demonstrations).
530. (Min. 530) STRUCTURE, PROPERTIES, AND OCCURRENCE OF CLAY MINERALS (2-5) Structure analysis and identification of clay minerals; mineral transformation and behavior; occurrence, genesis, and petrography of fine-grained sediments. *Messrs. Brindley and Bates*

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in ceramic technology studies are listed under Mineral Sciences. The subject of color in glasses is treated in Min. 521.

## CHEMICAL ENGINEERING

MERRELL R. FENSKE, *Head of the Department*  
131 Chemical Engineering Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Fenske, Quiggle, and Rose; Associate Professors Braun, Carnahan, Hersh, Jones, Klaus, and McCormick; Assistant Professors Engel and Lloyd.

Course offerings or research facilities are available in the following areas: phase equilibria, thermodynamics, unit operations, unit processes, nuclear chemical engineering, petroleum technology, rheology, and lubrication. The facilities for instruction and research in chemical engineering and petroleum chemistry include those of the Petroleum Refining Laboratory.

To be admitted, a student should be a graduate of an accredited curriculum in chemical engineering or the equivalent. Graduates of other accredited engineering or physical science curriculums may be admitted but will be required to make up certain undergraduate deficiencies without graduate credit.

Thesis research work in petroleum chemistry, for the M.S. and Ph.D. degrees in chemistry, may be done in the Department of Chemical Engineering.

## CHEMICAL ENGINEERING (CH E)

- |                                                                                                                                        |                                |
|----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| 404. CHEMICAL PLANT DESIGN (3)                                                                                                         | <i>Messrs. Engel and Lloyd</i> |
| 405. THERMODYNAMICS FOR CHEMICAL ENGINEERS (3)                                                                                         | <i>Mr. Snyder</i>              |
| 406. CHEMICAL ENGINEERING PROBLEMS (3)                                                                                                 | <i>Messrs. Engel and Lloyd</i> |
| 410. CHEMICAL ENGINEERING PRINCIPLES (3)                                                                                               | <i>Mr. Carnahan</i>            |
| 411. CHEMICAL ENGINEERING PRINCIPLES (3)                                                                                               | <i>Mr. Carnahan</i>            |
| 412. CHEMICAL ENGINEERING PRINCIPLES (3)                                                                                               | <i>Mr. Carnahan</i>            |
| 420. CRYOGENIC ENGINEERING (3)                                                                                                         | <i>Mr. Fritz</i>               |
| 422. PETROLEUM PROCESSES AND PRODUCTS (2)                                                                                              |                                |
| 430. NUCLEAR CHEMICAL ENGINEERING (3)                                                                                                  | <i>Mr. Lloyd</i>               |
| 440. CHEMICAL ENGINEERING MATERIALS (3)                                                                                                | <i>Mr. Engel</i>               |
| 445. CHEMICAL ENGINEERING RESEARCH (1-5)                                                                                               |                                |
| 450. PROCESS DYNAMICS (3)                                                                                                              |                                |
| 460. CHEMICAL ENGINEERING (4)                                                                                                          |                                |
| 500. SEMINAR IN CHEMICAL ENGINEERING (1) Required of all graduate students.                                                            |                                |
| 505. SPECIAL TOPICS IN CHEMICAL ENGINEERING (2-12) Intensive study in the various specialized fields of chemical engineering.          |                                |
| 510. ADVANCED HEAT TRANSFER I (3) Physical and chemical factors controlling the rate of heat transfer under conditions of steady flow. |                                |
| 511. ADVANCED HEAT TRANSFER II (3) Flow of heat under varying temperature conditions.                                                  |                                |
| 515. DISTILLATION (3) Commercial distillation, equilibrium diagrams, vapor composition, stills and rectifying and stripping columns.   |                                |
| 516. ECONOMIC BALANCE (3) Problem work on the design of chemical engineering equipment from the economic standpoint.                   |                                |



## CHEMICAL ENGINEERING

518. CHEMICAL ENGINEERING DESIGN (3) Complicated examples are discussed and worked out. Several different unit operations will be combined for the design of a complete installation.
520. EXTRACTION PROCESSES (3) Equilibrium extraction data and phase contacting and settling related to equipment design.
521. MASS TRANSFER (3) Problem course on developments in diffusion, fluid dynamics, and phase equilibrium.
524. CHEMICAL ENGINEERING, APPLICATION OF THERMODYNAMICS (3) Elements of thermochemistry and thermodynamics of greatest importance in chemical engineering.
530. HEAT TRANSFER IN NUCLEAR REACTORS (3) Fluid flow, heat transfer, and design problems in nuclear reactor systems. *Mr. Lloyd*
535. APPLIED REACTION KINETICS (3) Basic principles of chemical kinetics, simultaneous heat and mass transfer, and prediction of rates; their application to reactor design.

## CHEMISTRY

THOMAS WARTIK, *Head of the Department*  
212 Whitmore Laboratory

*Degrees Conferred:* Ph.D., M.S., M.Ed.

*Graduate Faculty:* Professors Aston, Brickwedde, Deno, Dixon, Fleming, Fritz, Hutchison, Jordan, Miller, Noll, Oakwood, Quiggle, Seward, Skell, Smith, Sommer, Taft, Wartik, Willard, and Zook; Associate Professors Ascah, Goodman, Haas, Hayes, Hisatsune, Jones, Lampe, Schempff, Shamma, and Steele; Assistant Professors Ginge-  
rich, Lotz, Richey, and Schmulbach.

Students may specialize in analytical, inorganic, organic, physical, and petroleum chemistry. The general facilities are excellent, and the computer, cryogenic, microscopy, petroleum, radiochemical, and spectroscopy laboratories provide unusual research opportunities. Distinguished visiting scholars conduct informal discussions each Thursday at 1 p.m. at a departmental colloquium.

Students entering programs leading to the M.S. and Ph.D. degrees should have had training which includes at least one year's work in each of the following: general chemistry, analytical chemistry, organic chemistry, physical chemistry, and general physics. Mathematics through integral calculus is required, and a reading knowledge of at least one foreign language, preferably German, is expected.

The program leading to the M.Ed. degree is designed primarily for science teachers in secondary schools. Previous training should include a total of 18 credits in chemistry.

Prior to scheduling their first term program, new students will take examinations in the four areas of analytical, inorganic, organic, and physical chemistry. The information obtained from these tests will assist both the student and his adviser in making up a program best suited to the student's needs. These examinations are normally given just prior to the regular registration period.

## CHEMISTRY (CHEM)

400. CHEMICAL LITERATURE (1)

*Mrs. Strauss*

401. SEMINAR (1)  
 405. NUCLEAR AND RADIOCHEMISTRY (3)  
 410. ADVANCED INORGANIC CHEMISTRY (4)  
 413. INORGANIC PREPARATIONS AND LABORATORY METHODS (2-5)  
 \*421-422. ANALYTICAL CHEMISTRY (4 each)  
 426. INSTRUMENTAL METHODS OF ANALYSIS (3-5)  
 435. ORGANIC PREPARATIONS AND LABORATORY METHODS (3-5)  
 437. QUALITATIVE ORGANIC ANALYSIS (3)  
 448. COLLOID CHEMISTRY (3)  
 \*451-452. PHYSICAL CHEMISTRY (3 each)  
 453. ADVANCED PHYSICAL CHEMISTRY (3)  
 454. ADVANCED PHYSICAL CHEMISTRY (3)  
 455. PHYSICAL CHEMISTRY OF HIGH POLYMERS (3)  
 \*457-458. EXPERIMENTAL PHYSICAL CHEMISTRY (1 each)  
 459. EXPERIMENTAL PHYSICAL CHEMISTRY (1)  
 470. CHEMICAL MICROSCOPY (3)  
 471. SPECIAL TOPICS IN CHEMICAL MICROSCOPY (2-6)  
 472. QUANTITATIVE ORGANIC MICROANALYSIS (3)  
 474. QUANTITATIVE ORGANIC MICROANALYSIS (3)  
 477. CHEMICAL PHOTOMICROGRAPHY (3)  
 489. INTRODUCTION TO CHEMICAL RESEARCH (1-10)  
 †490. ORGANIC CHEMISTRY (5)  
 †491. ORGANIC CHEMISTRY (5)  
 †492. ADVANCED GENERAL CHEMISTRY FOR TEACHERS (3)  
 †493. SELECTED TOPICS IN CHEMISTRY FOR TEACHERS (3)  
 †494. CHEMICAL DEMONSTRATIONS FOR TEACHERS (3)
500. SEMINAR IN INORGANIC CHEMISTRY (1 per term)  
 501. SEMINAR IN PHYSICAL CHEMISTRY (1 per term)  
 502. SEMINAR IN ORGANIC CHEMISTRY (1 per term)  
 503. SEMINAR IN ANALYTICAL CHEMISTRY (1 per term)
- 516-517. INORGANIC CHEMISTRY (3 each) Systematic treatment of inorganic chemistry in terms of modern concepts.  
 518. SPECIAL TOPICS IN INORGANIC CHEMISTRY (3 per term) Modern developments in specialized fields.  
 525. ANALYTICAL PROCESSES (3) Separative and determinative processes in analytical chemistry.  
 526. MODERN INSTRUMENTAL ANALYSIS (3)  
 527. SPECIAL TOPICS IN ANALYTICAL CHEMISTRY (2-12)  
 531. SPECIAL TOPICS IN ORGANIC CHEMISTRY (3-12)  
 532. ORGANIC NITROGEN COMPOUNDS (3) Chemistry, stereochemistry, and molecular structure of organic compounds containing nitrogen. *Mr. Aston*  
 534. THEORETICAL ORGANIC CHEMISTRY (3) Modern theories of structure; resonance; interpretation of physical properties; theory of rates; equilibrium properties. *Mr. Aston*

*Miss Willard*  
*Miss Willard*  
*Mr. Fleming*  
*Mr. Fleming*  
*Miss Willard*

\*Graduate credit not allowed for students majoring in chemistry or chemical engineering.  
 †Candidates for the M.Ed. degree.

## CHEMISTRY

- 535-536. ORGANIC CHEMISTRY (3 each) Adapted to the needs of those doing research work in organic chemistry.
537. ORGANIC CHEMISTRY OF HIGH POLYMERS (3) High polymer theory and practice from the viewpoint of organic chemistry.
538. ORGANIC CHEMISTRY (3) Survey of organic chemistry arranged primarily for graduate students majoring in fields other than organic chemistry.
539. STEREOCHEMISTRY (3) Comprehensive treatment of the principles of stereochemistry as applied to organic compounds. *Mr. Oakwood*
540. EXPERIMENTAL METHODS OF PHYSICAL CHEMISTRY (3-5)
541. PHASE RULE (3) The phase rule and its applications.
542. COLLOIDS (3) The physics and chemistry of surfaces and their resulting colloid properties; methods of preparing colloids. *Mr. Smith*
544. CHEMICAL THERMODYNAMICS (3) Development of thermodynamic theory with special reference to common physical changes and chemical reactions. Prerequisite: Chem. 452.
545. CHEMICAL THERMODYNAMICS AND INTRODUCTORY STATISTICAL MECHANICS (3) Continuation of Chem. 544 including the calculation of thermodynamic properties from molecular and spectroscopic data. Prerequisite: Chem. 544.
546. QUANTUM CHEMISTRY (3) Calculation of electronic properties of atoms and molecules by wave mechanical methods including molecular orbital theory. Prerequisite: Chem. 565.
547. STATISTICAL MECHANICS (3) Properties of matter at equilibrium, developed on the basis of energy levels of molecules and statistical mechanical theory. Prerequisite: Chem. 565.
548. CATALYSIS (3) Theory of catalysis and its application to industry.
560. TOPICS IN PHYSICAL CHEMISTRY (3-12)
- 561-562. CHEMICAL PRINCIPLES (3 each) Mathematical treatment of the classical principles of chemistry; their application to problems. Required of all graduate students. Prerequisites: Chem. 452, Math. 44, Phys. 204. A course in organic chemistry is recommended.
563. CHEMICAL KINETICS (3) Theory and measurement of the rates of chemical reactions; the mechanism of chemical reactions.
564. CHEMICAL KINETICS (3) Continuation of Chem. 563 including theory and measurement of photochemical reactions.
565. ATOMIC AND MOLECULAR STRUCTURE (3) Introduction to modern theoretical chemistry: chemical bonds and molecular spectra.
567. ADVANCED THEORETICAL CHEMISTRY (3) Modern and current theories of the properties of chemical substances and their applications to chemical problems; the construction of chemical theory.
581. EXPERIMENTAL METHODS IN PETROLEUM CHEMISTRY (1-12)
582. TOPICS IN PETROLEUM CHEMISTRY (2-6)



# CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS

## CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS

WINONA L. MORGAN, *Head of the Department*  
105E Home Economics South

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Britton, Harms, Morgan, Siegel, and Smith; Associate Professors Broderick and de Lissovoy.

Students may specialize in the guidance and development of children, relationships among various members of the family, problems of all stages of the family cycle, nursery school education, education for home and family living in the schools, parental education, and work with children and families in community agencies.

The entering student should have had at least 6 credits in the physical and biological sciences, 12 in the social sciences (which must include a basic course in sociology and one in psychology), and 6 in child development and family relationships. Students who are otherwise qualified but who lack some of these credits may be admitted and permitted to make up the deficiency credits along with a graduate program.

### CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS (CD FR)

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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| 418. FAMILY RELATIONSHIPS (3)                                                                                                                                                                                                                              | <i>Mr. Broderick</i>   |
| 429. ADVANCED CHILD DEVELOPMENT (3)                                                                                                                                                                                                                        | <i>Mr. de Lissovoy</i> |
| 430. OBSERVATION AND EXPERIENCE IN NURSERY SCHOOL (1-4)                                                                                                                                                                                                    | <i>Miss Russell</i>    |
| 441. NURSERY SCHOOL ORGANIZATION (3)                                                                                                                                                                                                                       | <i>Miss Russell</i>    |
| 445. (Psy. 445) DEVELOPMENT THROUGHOUT ADULTHOOD (3)                                                                                                                                                                                                       | <i>Mr. Britton</i>     |
| 481. EDUCATIONAL METHODS WITH PRESCHOOL CHILDREN (3)                                                                                                                                                                                                       | <i>Miss Russell</i>    |
| 500. NONTHESIS RESEARCH (1-6)                                                                                                                                                                                                                              |                        |
| 508. PARENTAL EDUCATION (3) Discussion and use of methods, experiences, and programs which can be used effectively to help parents in dealing with problems of parent-child relationships. Prerequisites: C.D.F.R. 429, 430. <i>Miss Morgan</i>            |                        |
| 515. THE TEACHING OF CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS (3) Methods of selection and presentation of subject matter basic to understanding the development of children. <i>Miss Morgan</i>                                                         |                        |
| 529. (Psy. 529) SEMINAR IN CHILD DEVELOPMENT (1-6) Readings and reports on recent findings in child development. Prerequisites: 6 credits in child development or 6 in educational or child psychology, plus 3 in statistics. <i>Miss Harms</i>            |                        |
| 530. PROBLEMS IN CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS (1-6) Problems involving individual research in library, laboratory, or field projects.                                                                                                        |                        |
| 536. (Psy. 536) RESEARCH METHODS IN CHILD DEVELOPMENT (3) Prerequisites: 6 credits in child development and a course in statistics. <i>Mrs. Siegel</i>                                                                                                     |                        |
| 545. THE FAMILY IN ITS COMMUNITY (3) Cultural influences on family relationships; how the family orients its members to community living and group participation. <i>Mr. Broderick</i>                                                                     |                        |
| 546. SEMINAR IN FAMILY RELATIONSHIPS (1-6) Reading, reports, and discussion of recent research in relationship aspects of family living; particular attention to studies of roles, crises, and adjustments within the family setting. <i>Mr. Broderick</i> |                        |

## CHILD DEVELOPMENT AND FAMILY RELATIONSHIPS

549. (Psy. 549) THEORIES OF CHILD DEVELOPMENT (2-3) Historical background of the major theories concerning child development and behavior and their application. *Mr. Harris*

## CIVIL ENGINEERING and SANITARY ENGINEERING

BENJAMIN A. WHISLER, *Head of the Department of Civil Engineering*  
208 Sackett Building

*Degrees Conferred:* Civil—Ph.D., M.S., M.Eng.; Sanitary—M.S., M.Eng.  
*Graduate Faculty:* Professors Kountz, Perez, Reen, Shulits, and Whisler; Associate Professors Gotolski, Nesbitt, and Underwood; Assistant Professor Barnoff.

The entering student should be a graduate in civil engineering from an accredited college of engineering. Students may specialize in structures, hydraulics, transportation engineering, surveying, and sanitary engineering, or combinations of these, through courses offered both by the Department of Civil Engineering and by other departments of the University.

### CIVIL ENGINEERING (C E)

400. SEMINAR (1-3)  
401. CIVIL ENGINEERING PROJECTS (2-12)  
412. ADVANCED PHOTOGRAMMETRY (3)  
421. HIGHWAYS AND STREETS (3)  
423. HIGHWAY SAFETY AND TRAFFIC CONTROL (3)  
431. CIVIL ENGINEERING CONSTRUCTION (3)  
446. ADVANCED SOIL MECHANICS (3)  
447. ADVANCED STRUCTURAL ANALYSIS (3)  
448. ADVANCED STRUCTURAL DESIGN (3)  
451. ADVANCED HYDROLOGY (3)  
462. OPEN CHANNEL HYDRAULICS (3)  
465. RIVER AND WATERWAYS ENGINEERING (3)  
471. MUNICIPAL AND RURAL SANITATION (3)  
472. TREATMENT PLANTS (3)
500. SEMINAR IN CIVIL ENGINEERING (1-6) Reports on researches and special topics. Course may be continued in subsequent terms.
521. TRANSPORT PLANNING AND DESIGN (2-6) Planning and design of transportation facilities; basic principles and engineering techniques applied to airways, highways, pipe lines, railways, waterways. Prerequisite or concurrent: C.E. 51 or 421.
522. TRANSPORT OPERATION AND MAINTENANCE (2-6) Engineering problems in operation, maintenance, and administration of airways, highways, pipe lines, railways, waterways. Prerequisite or concurrent: C.E. 51 or 421.
540. ADVANCED STRUCTURAL ANALYSIS (2-4) Geometry of flexure, deflections; analysis of continuous beams, rigid frames, arches; influence lines. Prerequisite: C.E. 46.
541. ADVANCED STRUCTURAL ANALYSIS (2-4) Truss deflection; trusses with redundant members, continuous trusses, framed arches; influence lines; secondary



## CIVIL ENGINEERING

- stresses; wind stresses; space framework; suspension bridges. Prerequisite: C.E. 46.
542. **APPLIED SOIL MECHANICS (2-5)** Soil classification by type of clay minerals and profile development; aerial photographic interpretation of soils and applications to site selection for dams, highways, and airports. Prerequisites: C.E. 412, 446.
543. **STRUCTURAL ENGINEERING PROJECTS (3-10)** Investigation or design projects in concrete, soil mechanics, photoelasticity, analysis, etc. Prerequisite or concurrent: C.E. 447, 448.
544. **ADVANCED STRUCTURAL DESIGN (2-4)** Plain and reinforced concrete design as applied to buildings, bridges, retaining walls, domes, tanks, and dams; prestressed concrete. Prerequisite: C.E. 448.
545. **ADVANCED STRUCTURAL DESIGN (2-4)** Structural steel design as applied to riveted and welded girders, trusses, rigid frames, wind connections; timber design. Prerequisite: C.E. 41.
547. **ADVANCED STRUCTURAL THEORY (3-6)** Prestressed concrete, arches, suspension bridges, concrete dams, thin shells, and other current topics. Prerequisite: C.E. 447.
550. **ENGINEERING CONSTRUCTION (2-4)** Construction methods applied to foundations, buildings, bridges, and other civil engineering construction work. Prerequisites: C.E. 41, 42.
551. **HYDROLOGIC INVESTIGATIONS (2-8)** Application of hydrologic principles and techniques to a specific project. Prerequisite: C.E. 451.
560. **DIMENSIONAL ANALYSIS AND THEORY OF MODELS (3)** Principles of dimensional analysis and similitude with engineering applications.
564. **HYDRAULIC ENGINEERING DESIGN (2-8)** Design and analysis of selected units of a typical hydraulic engineering project.
565. **TRANSPORTATION OF SOLIDS BY FLUIDS (2-5)** Fundamentals of the flow of solids in open and closed conduits; e.g., suspended load and bed load in rivers, slurries and pulp stocks in pipes.
571. **WATER PURIFICATION AND SOFTENING (3)** Current methods of softening, disinfecting, and conditioning water for municipal and industrial use. Prerequisite: C.E. 70.
572. **SEWAGE TREATMENT (3)** Modern methods of sewage treatment. Prerequisite: C.E. 70.
573. **ADVANCED PROBLEMS IN SANITARY ENGINEERING (3-10)** Investigations, analyses, and reports on current topics in sanitary engineering.
574. **ANALYTICAL EVALUATIONS IN SANITARY ENGINEERING (3)** Experiments illustrating current chemical and biochemical methods of water and waste treatment and analytical methods used in research and control.
575. **ADVANCED INDUSTRIAL WASTE TREATMENT (3)** Techniques of industrial waste treatment; attendant stream pollution and stream self-purification factors. Prerequisite: C.E. 472 or 572.
576. **WATER TREATMENT PLANT DESIGN (1-6)** Design of works for treatment of water for municipal and industrial use. Prerequisite: C.E. 71.
577. **SEWAGE TREATMENT PLANT DESIGN (1-6)** Design of works for treatment of sewage or industrial wastes. Prerequisite: C.E. 71.



## CIVIL ENGINEERING

578. INDUSTRIAL HYGIENE (3) Principles of control of industrial toxics and the protection of the worker and the community.
579. PUBLIC HEALTH ADMINISTRATION (3) Operation and duties of health departments at the various levels.

## CLINICAL SPEECH

EUGENE T. McDONALD, *Director of the Speech and Hearing Clinic*  
2S Sparks Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.  
*Graduate Faculty:* Professors McDonald and Siegenthaler; Associate Professors Berlin and Frick; Assistant Professor Raabe.

Students may specialize in either speech correction or audiology. Admission to study for the master's degree requires 27 credits in clinical speech and hearing, education, and psychology, including at least 9 in speech correction and/or audiology. Applicants for the M.S. degree must have had a course in statistics; applicants for the M.Ed. degree must have had student teaching. Applicants for the M.S. degree may count credits in speech science toward the required 27 credits.

### SPEECH EDUCATION (SP ED)

430. HEARING PROBLEMS AND THE TESTING OF HEARING (3)  
434. AUDIOMETRY AND HEARING AIDS (3)  
435. CLINICAL PRACTICE WITH THE HEARING HANDICAPPED (1-6)  
436. INTRODUCTION TO SPEECH CORRECTION (3)  
437. CLINICAL PRACTICE IN SPEECH CORRECTION (1-3)  
440. SPEECH EDUCATION FOR THE CLASSROOM TEACHER (2-3)  
441. CURRENT PROBLEMS IN SPEECH AND HEARING (1-6)  
442. SPEECH PATHOLOGY (3)  
443. METHODS IN AUDITORY TRAINING AND SPEECH READING (3)  
445. THE PUBLIC SCHOOL SPEECH CORRECTION PROGRAM (3)
525. SEMINAR IN CLINICAL SPEECH PATHOLOGY (3-9) Prerequisites: Sp.Ed. 436, 442.  
Unit A. *Cleft Palate*  
Unit B. *Cerebral Palsy*  
Unit C. *Aphasia*
530. SEMINAR IN AUDIOLOGY (2-4) Review of theories of hearing and review of related physiological and psychological researches. Prerequisite: Sp.Ed. 434.
537. ADVANCED CLINICAL PRACTICE IN SPEECH CORRECTION (1-9) Prerequisites: Sp.Ed. 437, 442.  
Unit A. *Diagnostic Procedures* (1-3)  
Unit B. *Treatment Procedures* (1-6)
540. ARTICULATION DISABILITIES (3) Speech-sound production disorders in children and adults; methods of examination, diagnosis, and treatment. Prerequisites: Sp.Ed. 437, 442.
541. THE VOICE AND ITS DISORDERS (3) Physical, physiological, and psychological bases of voice production; causes, nature, and symptoms of its disorders; current clinical methods in voice improvement. Prerequisites: Sp.Ed. 437, 442.

## CLINICAL SPEECH

542. STUTTERING AND ALLIED DISORDERS (3) Modern theories of causes of disorders of rhythm; methods of examination, diagnosis, and treatment. Prerequisites: Sp.Ed. 437, 442.
543. DIAGNOSTIC PROCEDURES IN CLINICAL SPEECH (3) Clinical instrumentation; case history taking; examination procedures and materials used in diagnosing speech disabilities; interpretation of findings; report preparation. Prerequisites: Sp.Ed. 437, 442.

## CLOTHING AND TEXTILES

RUTH W. AYRES, *Head of the Department*  
120A Home Economics Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professor Ayres; Associate Professors Densmore and Gates.

Work may be taken with major emphasis in the textile area, which stresses the background natural sciences, or in the clothing area, which stresses the background social sciences. Candidates are accepted who have a strong foundation and a good record in any of the following: home economics, chemistry, sociology, economics, or psychology.

### CLOTHING AND TEXTILES (CL TX)

400. SPECIAL PROBLEMS IN CLOTHING AND TEXTILES (1-6)
402. FUNDAMENTAL PRINCIPLES OF TAILORING CONSTRUCTION (3) *Mrs. Larson*
403. CREATIVE PATTERN MAKING (3) *Mrs. Larson*
404. DRAPING (3) *Mrs. Larson*
406. FASHION PROMOTION (3)
407. THE TEXTILE AND CLOTHING INDUSTRY (3) *Miss Ayres*
408. INTERMEDIATE TEXTILES (3) *Miss Densmore*
410. CLOTHING FOR THE FAMILY (3) *Mrs. Adams*
411. ADVANCED CLOTHING CONSTRUCTION (3) *Mrs. Larson*
500. NONTHESIS RESEARCH (1-6)
503. ADVANCED PATTERN DEVELOPMENT (3) Analysis of advanced pattern designing principles to give students facility in original designing.
504. ADVANCED DRAPING (3) Analysis of principles and techniques as a basis for creation of original designs; survey of literature in dress design.
505. CLOTHING INSTRUCTIONAL MATERIALS (3) Development of instructional materials and techniques based on needs of diverse groups.
506. THE FASHION WORLD (3) *Miss Gates*
507. PROBLEMS IN RELATION TO CLOTHING CONSUMPTION (3) Problems connected with manufacture and consumption of clothing; interrelation of textile and clothing trades with other industries. *Miss Ayres*
508. SPECIAL PROBLEMS IN CLOTHING AND TEXTILES (1-6) Individual directed study, investigation, and practice in selected phases of textiles and clothing.
509. SEMINAR IN CLOTHING AND TEXTILES (1-6)

## CLOTHING AND TEXTILES

510. RESEARCH METHODS AND EVALUATION IN CLOTHING AND TEXTILES (1-6)  
*Misses Densmore and Gates*
511. CURRENT DEVELOPMENTS IN CLOTHING AND TEXTILES (1-6)
512. HISTORY OF CLOTHING AND CLOTHING CONSTRUCTION (3) *Miss Gates*
513. ADVANCED TEXTILE TECHNOLOGY (6) *Miss Densmore*

## COMPARATIVE LITERATURE

PHILIP A. SHELLEY

*Chairman of the Committee on Comparative Literature*  
229 Sparks Building

*Degrees Conferred: Ph.D., M.A.*

Programs are arranged through a meaningful selection of courses offered by the several departments of languages and literatures, both ancient and modern, as well as of those specifically in the category of comparative literature. More than a minimum knowledge of foreign languages is required.

### COMPARATIVE LITERATURE (C LIT)

400. COMPARATIVE METHOD IN LITERARY STUDIES (3) *Miss Lüders*
443. (Ger. 443) LITERARY RELATIONS OF GERMANY WITH ENGLAND AND AMERICA  
(3-9) *Mr. Shelley*
470. OLD MASTERS OF THE MODERN NOVEL (3) *Mr. Morse*
480. INTRODUCTION TO FOLKLORE (3) *Mr. Bayard*
500. SEMINAR IN COMPARATIVE LITERATURE (3-6)
508. NORSE AND GAELIC SAGAS (3) Medieval Irish and Scandinavian prose tales surveyed and compared with respect to backgrounds, development, themes, and characteristics. *Mr. Bayard*
570. FORCES IN CONTEMPORARY EUROPEAN LITERATURE (3) The intellectual currents that have influenced European writers of the mid-twentieth century; Beckett, Böll, Robbe-Grillet, and others. *Mr. Morse*

## COUNSELING IN EDUCATION

GEORGE R. HUDSON

*In Charge of Graduate Programs in Counseling in Education*  
422 McAllister Building

*Degrees Conferred: Ph.D., D.Ed., M.S., M.Ed.*

*Graduate Faculty: Professor Wellington; Associate Professor Hudson; Assistant Professor Hylbert.*

Professional preparation programs are offered at the master's level for elementary or secondary school counselors, home and school visitors, college counselors, and rehabilitation counselors. Doctoral programs prepare for pupil personnel administration, college student personnel administration, or supervision of rehabilitation.



## COUNSELING IN EDUCATION

All candidates for graduate degrees in counseling in education must present for admission at least 27 undergraduate credits in economics, education, psychology, sociology, and physiology or anatomy, with some credits in at least three of these areas.

Prospective school counselors and home and school visitors must have a teaching certificate to enter the program and must have two years of teaching experience before receiving a degree. Those wishing to become college counselors must have a year of college teaching or college personnel experience to qualify for a degree. Since graduate students in rehabilitation counseling combine a supervised internship with professional training, their master's degree program is correspondingly lengthened.

A candidate for either a Ph.D. or a D.Ed. degree in counseling in education must spend at least three consecutive terms in residence after earning the master's degree. Students may be employed during this required residence period not to exceed one-half-time, thereby necessitating an extension of their residence requirements accordingly.

The following courses are used in the graduate programs of majors in counseling in education: Ed.Ser. 403, 404, 408, 409, 490, 494, 503, 505, 506, 507, 508, 509, 511, 512, 513, 522, 545, 551, 598, 600 or 610; Psy. 414, 418, 426, 436, 437, Psy. (C.D.F.R.) 445, Psy. 450, 482, 502, 535; Soc. 403, 426, 427, 450; Pl.Sc. 433; Anthy. 402; Econ. 404.

## DAIRY SCIENCE

DONALD V. JOSEPHSON, *Head of the Department*  
105 Borland Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Almquist, Josephson, and Patton; Associate Professors Flipse, Keeney, Kesler, and Watrous.

Students may specialize in dairy products manufacture, chemistry of milk and dairy products, dairy cattle nutrition, dairy cattle management, and physiology of reproduction. The minor program is generally taken in agricultural and biological chemistry, bacteriology, zoology, or agricultural economics.

Prerequisite to graduate work is the completion of an undergraduate curriculum in dairy science or a related science area. The undergraduate program must include college algebra and general physics. Students may be admitted with limited deficiency but are required to make up undergraduate deficiency work without degree credit.

### DAIRY SCIENCE (D SC)

- |                                                                                                                                               |                            |
|-----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| 418. DAIRY SURVEY (1)                                                                                                                         | Mr. Josephson              |
| 421. TECHNICAL CONTROL PROBLEMS (1-10)                                                                                                        | Messrs. Watrous and Keeney |
| 427. MILK SECRETION (3)                                                                                                                       | Mr. Kesler                 |
| 428. DAIRY PRODUCTION PROBLEMS (1-6)                                                                                                          | Mr. Kesler and Staff       |
| 431. PHYSIOLOGY OF REPRODUCTION IN FARM ANIMALS (3)                                                                                           | Mr. Almquist               |
| 501. BUTTER AND CHEESE (1-6) Manufacture and handling of butter and cheese.<br>Prerequisites: D.Sc. 10, 23, Bact. 8, A.B.Ch. 403. Mr. Watrous |                            |
| 502. CONDENSED MILK AND MILK POWDER (1-6) Condensing and drying of milk.<br>Prerequisites: D.Sc. 10, 26, Bact. 8, A.B.Ch. 403. Mr. Keeney     |                            |
| 503. PUBLIC MILK PROBLEMS (1-6) Handling milk in modern plants. Prerequisites: D.Sc. 11, Bact. 8, A.B.Ch. 403. Mr. Watrous                    |                            |

## DAIRY SCIENCE

504. ICE CREAM MANUFACTURE (1-6) Manufacture of ice cream, ices, and other frozen milk products. Prerequisites: D.Sc. 11, Bact. 8, A.B.Ch. 403. *Mr. Keeney*
505. DAIRY PLANT ECONOMICS (1-6) Economic factors involved in creamery operation and management. Prerequisites: D.Sc. 7, 11. *Mr. Watrous*
507. DAIRY CATTLE MANAGEMENT (1-6) Management of dairy cattle. Prerequisite: D.Sc. 27. *Mr. Kesler and Staff*
508. DAIRY SEMINAR (1-6) Preparation and presentation of a paper on an assigned subject.
509. TESTING DAIRY PRODUCTS (1-6) Constituents of dairy products. Prerequisites: D.Sc. 11, Bact. 8, A.B.Ch. 403.
510. DAIRY CATTLE FEEDING (1-6) Application of fundamental research in animal nutrition to the feeding of dairy cattle. Prerequisites: D.Sc. 1, 29. *Mr. Kesler*
511. DAIRY CATTLE NUTRITION (1-6) Nutritional requirements of dairy cattle. Prerequisite: A.Ntr. 401. *Mr. Kesler*
512. ADVANCED STUDIES IN MILK SECRETION (1-6) Physiology of milk secretion. Prerequisite: D.Sc. 427. *Mr. Kesler*
513. DAIRY CATTLE SELECTION (1-6) Breed history, pedigrees, selection, and judging of dairy cattle. Prerequisite: D.Sc. 1.
515. ADVANCED PHYSIOLOGY OF REPRODUCTION IN FARM ANIMALS (1-6) *Mr. Almquist*
516. ARTIFICIAL BREEDING OF FARM ANIMALS (1-6) Prerequisite: D.Sc. 431. *Mr. Almquist*
517. DAIRY SCIENCE LITERATURE (1-6) Review and reporting of dairy literature. *Mr. Josephson and Staff*
521. DAIRY RADIOPHYSIOLOGY (3) Metabolism and physiology of radioactive compounds; their use as tracers in animal physiology and the effects of radiation on metabolic processes. Prerequisite: Chem. 405. *Mr. Flipse*
522. RESEARCH PROCEDURES IN DAIRY TECHNOLOGY (3) Research problems and methods in dairy technology with major emphasis on dairy chemistry. Prerequisite: A.B.Ch. 403. *Mr. Patton*

## EARTH SCIENCES

HANS NEUBERGER

*Chairman of the Committee on Earth Sciences*  
323 Mineral Industries Building

*Degree Conferred: M.Ed.*

This program is designed to meet the needs of science teachers in secondary schools. The fields of study are astronomy, geography, geology, meteorology, mineralogy, and soils.

The program prepares candidates to teach at least one field of the earth sciences, familiarizes them with at least two additional earth science subjects, and at the same time enables them to increase their competence in the physical sciences, the biological sciences, and mathematics.

The student selects one of the earth sciences as an area of concentration, takes at least 12 credits in it, and is required to write a term paper in that area. An additional 12 credits must be taken in at least two other fields of earth sciences, or in two earth science fields plus two courses selected from the biological sciences, chemistry, mathematics, or physics. Furthermore, 6 credits in educational foundations are required as a minor.

## ECONOMICS

WARREN C. ROBINSON, *Acting Head of the Department*  
124 Boucke Building

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Professors Budd, Hensch, Hexner, Kaufman, Mason, Newman, Reede, Saylor, and Stout; Associate Professors Kautz, Klein, Mares, Myers, Prybyla, and Sauerlender; Assistant Professors Iwand and Robinson.

Opportunities are available for concentration in business statistics, economic theory, labor, international economics, government economic policy, money, credit, and public finance.

To enter graduate work in economics a student should have completed 6 credits in economic principles, 9 in the social sciences, and either 3 in statistics or 6 in mathematics.

### BUSINESS STATISTICS (B S)

- 500. SEMINAR IN BUSINESS STATISTICS (3-6)
- 501. ADVANCED BUSINESS STATISTICS (3)

### ECONOMICS (ECON)

- 400. HISTORY OF ECONOMIC THOUGHT (3)
- 404. CURRENT ECONOMIC ISSUES (3)
- 405. ADVANCED ECONOMIC ANALYSIS (3)
- 406. ECONOMIC GROWTH: UNDERDEVELOPED AREAS (3)
- 412. ECONOMICS OF COLLECTIVE BARGAINING (3)
- 415. SOCIAL INSURANCE (3)
- 418. ECONOMICS OF WAGES AND EMPLOYMENT (3)
- 419. CASE STUDIES IN LABOR-MANAGEMENT RELATIONS (3)
- 423. STATE AND LOCAL TAXATION (3)
- 425. THE MONEY MARKETS (3)
- 428. INCOME AND EMPLOYMENT THEORY (3)
- 429. FEDERAL FINANCES (3)
- 433. INTERNATIONAL MONETARY ECONOMICS (3)
- 442. MONOPOLY, COMPETITION, AND THEIR REGULATION (3)
- 450. THE BUSINESS CYCLE (3)
- 451. ADVANCED MONEY, BANKING, AND FISCAL POLICY (3)
- 480. MATHEMATICAL ECONOMICS (3)
- 490. MEASUREMENT OF THE ECONOMY (3)
- 500. ECONOMICS SEMINAR (3-6)
- 501. RESEARCH METHODS IN ECONOMICS (3-6)



## ECONOMICS

506. PROBLEMS IN ECONOMICS (3-6) Planned individual projects involving library, laboratory, or field work.
507. SEMINAR IN INTERNATIONAL ECONOMICS: THEORY AND POLICY (3-6)
508. SEMINAR IN MONEY, CREDIT, AND PUBLIC FINANCE (3-6)
510. ECONOMETRICS (3) Statistical estimation in mathematically formulated economic relationships.
511. SEMINAR IN INDUSTRIAL DISPUTES (3)
512. WAGES (3)
513. DEVELOPMENT OF ECONOMIC DOCTRINES (3-6)
515. LABOR SEMINAR (3)
522. ADVANCED ECONOMIC THEORY (3-6) Theory of price and income determination.

## EDUCATIONAL ADMINISTRATION

WALTER J. DELACY

*In Charge of Graduate Programs in Educational Administration*  
156 Chambers Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Davison, DeLacy, McGarey, Miller, and Remaley; Associate Professors Bosch, McAulay, and Willower.

Professional preparation programs are offered at the master's level for elementary and secondary school principals and supervisors. Doctoral programs prepare for positions of supervising principal, assistant superintendent, and superintendent of schools.

Requirements for admission to a graduate program in educational administration include 18 approved undergraduate credits in education and psychology. Applicants for admission to the master's degree program are required to have had one year of teaching experience, or to be currently engaged in teaching. Two years of teaching experience are required for admission to the doctoral program.

Candidates for the D.Ed. and Ph.D. degrees are required to complete a minimum of three consecutive terms in residence.

From the time of initiation of a 600 or 610 thesis research program, all doctoral candidates shall continuously register for a minimum of 2 credits per term until the termination of the graduate program. Failure to register for doctoral thesis credits in any term, unless approved by the candidate's committee, shall be considered automatic withdrawal.

While candidates are required to specialize in a field of professional education, they are also encouraged to acquire a general education in the social sciences, the behavioral sciences, and the humanistic foundations.

Courses in educational administration (Ed.Ser. 480 and 565 to 582 inclusive) are listed under the offerings of the Department of Educational Services. Additional courses may be selected from other areas and departments to meet the student's needs, including certification requirements.

## EDUCATIONAL SERVICES

DEPARTMENT OF EDUCATIONAL SERVICES—This department (Franklin A. Miller, *Head*) offers graduate programs in counseling in education, clinical speech, educational administration, and higher education. It also offers the following course sequences which are not graduate majors:

Adult Education	460-461
History and Philosophy of Education	415-420, 516-523
Instructional Materials	435-445, 535-541
Research, Seminars, and Projects	596-599
Safety Education	450-452
Special Education	425-431, 525-529
Testing and Measurements	490-494, 590-595

These courses carry graduate credit and, with the approval of the student's adviser, may be applied toward the requirements for an advanced degree in any major field.

### EDUCATIONAL SERVICES (ED SER)

- 403. GUIDANCE PRINCIPLES AND PRACTICES (3)
- 404. TEACHING AND GROUP GUIDANCE ABOUT OCCUPATIONS (3)
- 408. INTRODUCTION TO VOCATIONAL REHABILITATION (3)
- 409. MEDICAL INFORMATION FOR COUNSELORS (3)
- 415. CHARACTER EDUCATION (2-3)
- 417. PHILOSOPHIC BASIS OF EDUCATION (3)
- 418. HISTORY OF EDUCATION IN THE UNITED STATES (2-3)
- 420. HISTORY OF MODERN EUROPEAN EDUCATION (3)
- 425. EDUCATION OF EXCEPTIONAL CHILDREN (2-3)
- 427. EDUCATION OF THE MENTALLY RETARDED (2-3)
- 429. EDUCATION OF THE MENTALLY GIFTED CHILD (1-3)
- 430. PRACTICUM IN THE EDUCATION OF ATYPICAL CHILDREN (1-8)
- 431. ATYPICAL CHILDREN AND EDUCATIONAL ADJUSTMENTS (3)
- 435. VISUAL AND OTHER SENSORY AIDS FOR TEACHERS (1-3)
- 436. PREPARATION OF EDUCATIONAL STILL PICTURES (2-3)
- 437. SCRIPTING AND SHOOTING EDUCATIONAL MOTION PICTURES (2-3)
- 438. EDITING AND SOUND RECORDING IN THE PRODUCTION OF EDUCATIONAL MOTION PICTURES (2-3)
- 442. MOTION PICTURES IN EDUCATION (2-3)
- 443. RADIO AND TELEVISION IN EDUCATION (3)
- 444. STILL PICTURES (1-2)
- 445. ADVANCED AUDIO-VISUAL EQUIPMENT (3)
- 450. VISUAL AND OTHER AIDS IN SAFETY EDUCATION (3)
- 451. TEACHING TRAFFIC SAFETY AND AUTOMOBILE OPERATION (3)
- 452. ORGANIZATION AND SUPERVISION IN SAFETY EDUCATION (3)
- 460. HISTORY, PHILOSOPHY, AND GENERAL ORGANIZATION AND ADMINISTRATION OF ADULT EDUCATION (1)
- 461. ORGANIZATION, TYPES, AND METHODS OF ADULT EDUCATION AND PARENTAL EDUCATION (1)
- 480. EDUCATIONAL ADMINISTRATION (2-3)
- 490. EDUCATIONAL STATISTICS AND MEASUREMENTS (2-3)
- 494. EDUCATIONAL TESTING PROGRAMS (3)
  
- 503. GUIDANCE SERVICES IN ELEMENTARY EDUCATION (3) Guidance services to elementary school students; guidance opportunities for elementary teachers and principals.
- 505. OCCUPATIONAL AND EDUCATIONAL INFORMATION (3) Occupational informa-

## EDUCATIONAL SERVICES

- tion for guidance purposes; educational information related to vocational choice and preparation. Prerequisite: Ed.Ser. 403.
506. STUDENT ANALYSIS PROCEDURES FOR COUNSELORS (3) Collection and use of data basic to the counselor's understanding of individuals; the counseling interview and techniques other than testing.
507. SUPERVISED EXPERIENCE IN STUDENT COUNSELING (3) Practice in the application of guidance principles and methods to cases counseled under supervision; case conferences; seminar in guidance techniques. Prerequisite: Ed.Ser. 403.
508. ORGANIZATION AND ADMINISTRATION OF GUIDANCE PROGRAMS (3) Principles, organization, personnel, functions, integration with school programs, evaluation. Prerequisite: Ed.Ser. 403.
509. CONTRIBUTIONS OF PROFESSIONAL PERSONNEL TO VOCATIONAL REHABILITATION (3) Contributions of medical, social, psychological, and other specialists through the team approach; professional ethics, medical problems. Prerequisites: Ed.Ser. 403, 408.
511. SUPERVISED PRACTICUM IN REHABILITATION COUNSELING (1-6) Application of principles and techniques of rehabilitation counseling to cases involving handicapped individuals. Prerequisites: Ed.Ser. 403, 408.
512. PROFESSIONAL EXPERIENCE IN REHABILITATION COUNSELING (1-6) Supervised internship with responsibility for a regular case load. Prerequisite: Ed.Ser. 511.
513. SUPERVISION OF GUIDANCE WORKERS (3) Practical experience in supervising and evaluating work of counselors. Prerequisite: Ed.Ser. 507.
516. SOCIAL FOUNDATIONS OF EDUCATION (2-4) Social institutions and functions and their relationship to public education; analysis of the functions assignable to formal education. Prerequisites: El.Ed. 311 or Sec.Ed. 331; Psy. 14.
517. ADVANCED PHILOSOPHY OF EDUCATION (2-4) Analysis of educational policy and practice for philosophic consistency and commitment; philosophical implication in selected educational literature.
518. EVOLUTION OF EDUCATIONAL THOUGHT (2-3) Rise of formal educational philosophy from Plato to John Dewey; preliminary reference to Chinese, Hindu, Chaldean, Persian, Hebrew, and Egyptian theories.
521. EDUCATION IN THE LATIN-AMERICAN COUNTRIES (2-3) Recent educational progress in Central and South America, with special reference to Mexico, Cuba, Puerto Rico, Brazil, Chile, and Argentina.
522. COMPARATIVE EUROPEAN EDUCATION (3) Educational policies and practices in school systems in western and central European nations. Prerequisite: Psy. 14.
523. EDUCATION IN RUSSIA, ASIA, AND THE MIDDLE EAST (2-3) Current educational activities in Soviet Russia and other eastern European countries; the Middle East, North Africa, and the Far East.
525. INTERNSHIP IN SPECIAL EDUCATION SUPERVISION (3-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
527. PROBLEMS IN THE EDUCATION OF THE MENTALLY RETARDED (1-4) Study of existing curriculums, instructional practices, educational programs; experimentation in curriculum building and materials construction. Prerequisites: teaching experience; Ed.Ser. 425 or 577, and Ed.Ser. 427.



## EDUCATIONAL SERVICES

529. PROBLEMS IN THE EDUCATION OF THE MENTALLY GIFTED (1-4) Analysis of educational needs of mentally gifted; curriculum construction and curricular materials. Prerequisites: teaching experience; Ed.Ser. 425 or 577, and Ed.Ser. 429.
535. SEMINAR IN CURRICULUM MATERIALS AND THEIR UTILIZATION (3) Advanced detailed analysis of mass communication media; relationships among these and educational objectives, individual differences in learners, and ideas to be communicated. Prerequisites: Ed.Ser. 435, Sec.Ed. 585, 6 credits in educational psychology.
540. INTERNSHIP IN AUDIO-VISUAL EDUCATION (3-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
541. LABORATORY IN ORGANIZATIONAL ASPECTS OF MATERIALS OF INSTRUCTION (1-3) Organizing, storing, circulating, and maintaining instructional material in an instructional materials library. Prerequisites: Ed.Ser. 435, Sec.Ed. 585.
545. HIGHER EDUCATION IN THE UNITED STATES (2-3) Historical perspective and current status; development of functions and structures; issues in curriculum, admissions, government, administration, and finance.
546. THE PRINCIPLES OF COLLEGE TEACHING (2-3) Principles involved in teaching at the college level; effective use of teaching aids; criteria used in evaluation.
547. INTERNSHIP IN COLLEGE TEACHING (3-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
548. CURRICULUMS IN HIGHER EDUCATION (2-3) Various types of curriculums and philosophies underlying them; ways in which curriculums are developed; elective versus required courses; evaluation of achievement.
549. COMMUNITY JUNIOR COLLEGE AND THE TECHNICAL INSTITUTE (2-3) Distinctive contributions to meeting the need for post-secondary education; development, functions, curriculum and instruction, government, administration and finance.
550. THE PROFESSIONAL EDUCATION OF TEACHERS (3) Development and present status of teacher education; objectives and standards; selection and guidance of students; personnel problems in relation to staff. Prerequisite: 6 credits in advanced courses in education and a course in educational psychology.
551. STUDENT PERSONNEL PROGRAMS AT THE COLLEGE LEVEL (2-3) Student personnel services in higher education; organization of student advisory programs; use of personnel data; co-curricular activities; student welfare.
552. ADMINISTRATION IN HIGHER EDUCATION (2-3) Philosophy of administration; principles of scientific management and their application in colleges and universities; case studies of administrative problems. Prerequisite: courses or experience in higher education.
555. SEMINAR IN COLLEGIATE EDUCATION (1-6) Special topics in higher education. Prerequisite: courses or experience in higher education.
565. PRINCIPLES OF SCHOOL SUPERVISION (2-3) Organization of supervision; planning the supervisory program; developing standards of teaching and learning; improvement of learning through tests and teacher rating. Prerequisites: 18 credits in education and 3 years' teaching experience.
566. THE ELEMENTARY SCHOOL PRINCIPAL AS SUPERVISOR (2-3)
567. THE SECONDARY SCHOOL PRINCIPAL AS SUPERVISOR (2-3) Improvement of

## EDUCATIONAL SERVICES

instruction; improvement of teachers in service; evaluation of teaching procedures; methods of supervision; selection and use of textbooks. Prerequisite: three years' teaching experience.

568. THE ELEMENTARY SCHOOL PRINCIPAL AS ADMINISTRATOR (2-3) Duties of the elementary school principal in organizing and administering his school.
569. THE SECONDARY SCHOOL PRINCIPAL AS ADMINISTRATOR (2-4) Problems of schedule making, teachers' meetings, curriculum making and revision, organization of extracurricular and guidance programs. Prerequisite: teaching experience.
570. ADMINISTRATION AND SUPERVISION IN BUSINESS EDUCATION (3) Work of administrators, supervisors, and others responsible for improvement of instruction in business education; use of vocational testing; job analysis. Prerequisite: 6 credits in secondary education.
571. THE EDUCATIONAL PLANT (2-3) School plant needs in terms of school population and curriculums; the building survey, developing a plant program, the building site, plant utilization, operation and maintenance, heating and ventilation, equipment, school building costs and finance. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
572. PUBLIC RELATIONS FOR SCHOOL ADMINISTRATORS (2-3) Utilization of public participation in the formulation of school policies; relation of the school staff to the public and techniques for informing the public about what schools can do. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
573. PUBLIC SCHOOL FINANCE (2-3) Financing of public education in relation to organization and control; the conceptual basis for local financial administration; taxation, state and federal aid, school revenue, and money management. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
574. STATE AND NATIONAL EDUCATION PROGRAMS (2-3) Existing state and federal functions and relations to education; proposed programs. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience, and previous work in school administration.
575. ADMINISTRATION OF ADULT EDUCATION IN THE PUBLIC SCHOOLS (3) The organization of a program of adult education; its legal status, finances, selection of teachers, learning personnel, housing, and other administrative problems connected with adult education. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
576. LEGAL ASPECTS OF SCHOOL ADMINISTRATION (3) Legal bases for the organization and administration of school districts and schools; the powers, rights, privileges, and responsibilities of school corporations, school boards, administrators, and personnel; the law and fiscal policies; the course of study, textbooks; contracts; taxes; torts; records; agents; and the judicial decisions involved. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
577. THE ADMINISTRATION OF PUBLIC SCHOOL EDUCATION FOR ATYPICAL CHILDREN (2-3) Problems connected with the instituting and organizing of classes for atypical children; the legal phases, finances, teaching personnel, pupil personnel, housing, equipment, courses of study, curriculum, etc. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.
578. DYNAMIC FACTORS IN SCHOOL ADMINISTRATION (2-3) Factors which make for the improvement of public schools; influences with which administrators may work to improve the schools in their local situations; subjection of data on indivi-



## EDUCATIONAL SERVICES

dual administrative situations to scientific check. Prerequisite: Ed.Ser. 480 or teaching or administrative or supervisory experience.

579. PUBLIC SCHOOL BUSINESS ADMINISTRATION (2-3) Business management applied to school management problems; budgeting, accounting, purchasing, insurance, school equipment, cafeteria management; transportation, salaries, personnel management, and auxiliary and coordinate agencies. Prerequisites: Ed.Ser. 480 or teaching or administrative or supervisory experience; Ed.Ser. 573.
580. SEMINAR IN SCHOOL ADMINISTRATION (1-6) Efficiency in supervision, methods of diagnosis and evaluation of teaching and learning procedure, improving instruction, maintaining teacher morale, stimulating cooperative work. Prerequisites: Ed.Ser. 480, 6 credits in educational administration.
581. EDUCATIONAL SURVEY TECHNIQUES (2-3) Methods for appraisal of an educational program; planning for expansion, consolidation, or reduction of educational offerings. Prerequisites: Ed.Ser. 480, 6 credits in educational administration.
582. INTERNSHIP IN ADMINISTRATION AND SUPERVISION (1-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
590. ADVANCED EDUCATIONAL STATISTICS (2-4) Appropriate measures and devices for experimental research in education including correlation measures, curve fitting, and analysis of variance. Prerequisite: 12 credits of graduate work in education including Ed.Ser. 490 or Psy. 415.
595. INTRODUCTION TO THE ADVANCED STUDY OF EDUCATION (1-3) Methods of educational research; criticism of studies and theses in education; initiating research projects; summarizing results of research. Prerequisite: Ed.Ser. 490 or Psy. 415.
596. SEMINAR IN EDUCATION (1-3) Conferences and discussions designed to meet the need for special study of particular fields in education. Prerequisite: 12 credits of graduate work in education.
597. WORKSHOP IN CURRENT EDUCATIONAL PROBLEMS (1-6) For administrators, supervisors, experienced elementary and secondary teachers, guidance workers; administrative, supervisory, and instructional problems involved in an emerging educational program. Prerequisite: 12 credits of graduate work in education.
598. PROBLEMS, PROJECTS, AND AREA STUDIES IN EDUCATION (1-6) Independent work in the study of topics in education or the development of new curriculums, materials, or procedures for teaching. Prerequisites: 12 credits of graduate work in education and approval of the department head.
599. INTERNSHIP IN PUBLIC SCHOOL RESEARCH (3-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.

## ELECTRICAL ENGINEERING

ARTHUR H. WAYNICK, *Head of the Department*  
105 Electrical Engineering Building

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Professors Holt, Tarpley, Volz, and Waynick; Associate Professors Atwater, Marsh, Pearson, Ross, Schmerling, and Shields; Assistant Professors Ferraro and Nisbet.



## ELECTRICAL ENGINEERING

Course offerings and research facilities are available in the following areas: information theory, microwave theory and techniques, networks, computers (including digital, analog, and network analyzer), control, power conversion, servomechanisms, tubes and transistors, dynamical machine analysis, power dispatching, relay protection, and wave propagation.

The entering student must hold a bachelor's degree in engineering or science and have satisfactorily completed undergraduate course work in electrical circuits, machinery, and electronics.

### ELECTRICAL ENGINEERING (E E)

- 421a,b,c,d. ELECTRICAL ENGINEERING PROBLEMS (2-12)
- 425. SYMMETRICAL COMPONENTS (3)
- 426. TRANSISTORS (3)
- 428. SERVOMECHANISMS (3)
- 432. MICROWAVE METHODS AND ANALYSIS (3)
- 435. ENGINEERING ANALYSIS (3)
- 438. ELECTROMAGNETIC THEORY AND RADIATING SYSTEMS (3)
- 439. PULSE TECHNIQUES (3)
- 441. ACTIVE CIRCUITS (3)
- 450. ELECTRICAL NETWORK THEORY (3)
- 461. FUNDAMENTALS OF POWER SYSTEM STABILITY (3)
- 470. ELECTRONIC ANALOG COMPUTERS (3)
- 471. LOGICAL DESIGN OF DIGITAL COMPUTERS (3)
  
- 520. SEMINAR (1) Required of all graduate students in electrical engineering. Conferences, reading, and presentation of technical papers.
- 521. ADVANCED ELECTRICAL ENGINEERING PROBLEMS (2-12)
- 523. NONLINEAR ANALYSIS (3) Transient and steady state analysis of nonlinear physical systems; phase plane analysis, iterative techniques, singular points, and subharmonics. Prerequisite: E.E. 435.
- 525. SYMMETRICAL COMPONENTS (3) Polyphase circuits and machines under unbalanced conditions of operation including effects of rotating machines upon distribution and transmission system performance; characteristics of phase converters and single-phase operation of polyphase systems. Prerequisite: E.E. 425.
- 528. SERVOMECHANISMS (3) Advanced treatment of transient and steady-state behavior of closed-cycle control systems with special attention to stability and design of stabilizing controllers. Prerequisite: E.E. 428.
- 532. ULTRA-HIGH-FREQUENCY ENGINEERING (3) Theory of wave guides and discontinuities, resonant cavities, traveling wave oscillators and devices; interaction of fields with matter. Prerequisite: E.E. 432 or 438.
- 535. ENGINEERING ANALYSIS (3) Engineering applications of complex variables, conformal mapping methods, and potential plotting; Laplace transform methods and stability criteria. Prerequisite: E.E. 435.
- 538. ELECTROMAGNETIC ENGINEERING (3) Electrical and magnetic fields, using the Maxwell-Lorentz equations as applied to vector fields and special solutions for antennae, wave guides, and other engineering applications. Prerequisite: E.E. 438.
- 550. PASSIVE NETWORK SYNTHESIS (3) Network synthesis using (a) realizability conditions; (b) image parameters, realization methods for two-terminal pair networks; rational fraction approximation; time domain synthesis. Prerequisite: E.E. 450.

## ELECTRICAL ENGINEERING

570. ADVANCED ELECTRONIC ANALOG COMPUTERS (3) Advanced techniques of analog computation and simulation; machine and problem errors; nonlinear differential equations. Prerequisite: E.E. 470.
571. DIGITAL COMPUTERS: RECENT DEVELOPMENTS AND ADVANCED LOGIC (3) Advanced treatment of logical design; discussion of topics of current interest in the general area of digital computers. Prerequisite: E.E. 471.
580. RADIO WAVES AND THE IONOSPHERE (3) The magneto-ionic theory of ionospheric wave propagation; ray-optical approximations; determination of ionization profiles; full wave solutions; nonlinear and coupling effects. Prerequisite: E.E. 43 or 438 or Phys. 557.
581. CONSTITUTION OF THE IONOSPHERE (3) Properties of neutral and ionized atmosphere above 60 km; photochemical processes; solar, meteoric perturbations of the ionosphere; large-scale movements in ionization.

## ELEMENTARY EDUCATION

A. MADISON BREWER, *Head of the Department*  
150 Chambers Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Bixby, Brewer, Murphy, and Russell; Associate Professors Alessandro, Bosch, Corle, McAulay, Veatch, and Zaffaroni.

The graduate programs provide advanced professional preparation for kindergarten teachers, elementary school teachers, and curriculum specialists. For admission 18 credits in elementary education, including teaching experience, are required.

### ELEMENTARY EDUCATION (EL ED)

426. PROBLEMS OF ELEMENTARY SCHOOL ARITHMETIC (2-3)
433. TEACHING SOCIAL STUDIES IN THE ELEMENTARY GRADES (2-3)
436. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE ELEMENTARY SCHOOL (3)
437. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE ELEMENTARY SCHOOL (3)
438. TEACHING SCIENCE IN THE ELEMENTARY SCHOOL (1-3)
443. THE ELEMENTARY SCHOOL READING PROGRAM (2-3)
444. READING DISABILITIES (2-3)
445. (Sec.Ed. 445) TECHNIQUES IN REMEDIAL READING (2-6)
449. TEACHING CHILDREN'S LITERATURE (2-3)
453. SPECIAL PROBLEMS IN THE TEACHING OF ELEMENTARY SCHOOL ENGLISH (2-3)
461. ELEMENTARY EDUCATION (2-3)
467. ADVANCED THEORY OF KINDERGARTEN (3)
479. MEASUREMENT OF ACHIEVEMENT IN THE ELEMENTARY SCHOOL (2-3)
485. WORKSHOP IN SELECTED STUDIES IN ELEMENTARY EDUCATION (1-6)
511. SUPERVISION OF STUDENT TEACHERS (3) A course in supervision for master teachers, department heads, and college teachers with supervisory responsibilities in teacher education. Prerequisite: teaching experience and 18 credits in education, including at least 5 in methods.

## ELEMENTARY EDUCATION

520. INTERNSHIP IN ELEMENTARY EDUCATION (3-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
546. (Sec.Ed. 546) SEMINAR ON READING INSTRUCTION (3-6) Research, procedures, and materials in reading readiness, word perception, basic reading skills, vocabulary development, reading in content subjects. Prerequisite: El.Ed. 443 or Sec.Ed. 443.
556. (Sec.Ed. 556) READING CLINIC PRACTICE: ANALYSIS OF READING DISABILITIES (3-6) Analysis of extreme reading disabilities and recommended remedial procedures; experience in preparation of case reports. Prerequisites: El.Ed. 444, El.Ed. (Sec.Ed.) 445.
557. READING CLINIC PRACTICE: REMEDIAL PROCEDURES (1-9) Practicum in special classes for reading disabilities; corrective and remedial procedures; specific procedures for correction of various types of reading disabilities. Prerequisite: El. Ed. 444 or El.Ed. (Sec.Ed.) 556.
559. READING CLINIC RESEARCH (1-15) Prerequisites: El.Ed. 443 or Sec.Ed. 443; El.Ed. 444.
562. PROBLEMS OF ELEMENTARY EDUCATION (2-3) Problems seminar for experienced educators. Prerequisite: 12 credits in education and psychology, including 6 in elementary education.
563. SEMINAR IN CONTEMPORARY ISSUES IN ELEMENTARY EDUCATION (1-3) Conferences and discussions designed to meet the needs of experienced teachers and principals in the field of elementary education. Prerequisite: 6 credits in elementary education and teaching experience.
564. ORGANIZATION OF THE ELEMENTARY SCHOOL CURRICULUM (2-3) Principles underlying curriculum construction. Primarily for elementary education majors. Prerequisite: El.Ed. 311 or teaching experience.
585. WORKSHOP IN CURRENT ELEMENTARY SCHOOL PROBLEMS (1-6) For experienced elementary school teachers, administrative, supervisory, and instructional problems involved in an emerging educational program. Prerequisite: 12 credits of graduate work in education.
594. SEMINAR IN EDUCATION (1-3) Conferences and discussions designed to meet the need for special study of particular fields in education. Prerequisite: 12 credits of graduate work in education.
598. PROBLEMS, PROJECTS, AND AREA STUDIES IN ELEMENTARY EDUCATION (1-6) Independent work in the study of topics in elementary education or the development of new curriculums, materials, or procedures for teaching. Prerequisites: 12 credits of graduate work in education and approval of the department head.

## ENGINEERING MECHANICS

JOSEPH MARIN, *Head of the Department*  
105 Hammond Building

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Professors Davids, Hardenbergh, Hu, Marin, Oppel, Vierck, and Wislicenus; Associate Professors Jaunzemis and Neubert; Assistant Professors Gaus, Sharma, and Wilkov.



## ENGINEERING MECHANICS

Graduate study is available in dynamics and vibrations, theory of elasticity and strength of materials, experimental stress analysis, theory of plasticity, solid state mechanics, mechanical properties of materials, and fluid mechanics.

The entering student must hold a bachelor's degree in engineering or science and have satisfactorily completed undergraduate courses in statics, dynamics, and strength of materials.

### ENGINEERING MECHANICS (E MCH)

- |                                                   |                                   |
|---------------------------------------------------|-----------------------------------|
| 400. ADVANCED STRENGTH OF MATERIALS (3)           | <i>Mr. Sharma</i>                 |
| 401. ELEMENTS OF VIBRATIONS (3)                   | <i>Messrs. Neubert and Vierck</i> |
| 402. APPLIED AND EXPERIMENTAL STRESS ANALYSIS (3) | <i>Mr. Oppel</i>                  |
| 403. MECHANICS OF THE SOLID STATE (4)             | <i>Mr. Hu</i>                     |
| 404. RESEARCH IN ENGINEERING MECHANICS (1-6)      |                                   |
| 407. NUMERICAL METHODS OF ANALYSIS (3)            | <i>Mr. Vierck</i>                 |
| 408. ELASTICITY AND ENGINEERING APPLICATIONS (3)  | <i>Mr. Sharma</i>                 |
| 409. ADVANCED MECHANICS (3)                       | <i>Mr. Hardenbergh</i>            |
| 410. MECHANICS OF SPACE FLIGHT (3)                | <i>Mr. Oppel</i>                  |
| 412. EXPERIMENTAL METHODS IN VIBRATIONS (3)       | <i>Mr. Neubert</i>                |
| 413. PLASTIC ANALYSIS OF STRUCTURES (3)           | <i>Mr. Hu</i>                     |
| 414. ELEMENTS OF MATERIAL SCIENCE (3)             | <i>Mr. Wilkov</i>                 |
| 421. CONTINUUM MECHANICS (3)                      | <i>Mr. Jaunzemis</i>              |
| 422. CONTINUUM MECHANICS (3)                      | <i>Mr. Jaunzemis</i>              |
500. ADVANCED MECHANICS OF MATERIALS (3-6) Strain energy methods; special problems in bending and torsion; curved bars, beams on elastic foundations; thick-walled cylinders, shrink-fit assemblies, and rotating discs; thin-walled pressure vessels; bending of thin plates; buckling of bars and plates. Prerequisite: E.Mch. 13. *Mr. Marin*
504. APPLIED ELASTICITY (3) Analyses of stress and strain in two dimensions; problems in elasticity and elastic stability; emphasis on applications to machine and structural design. Prerequisite: E.Mch. 13.
506. EXPERIMENTAL STRESS ANALYSIS (3) Experimental methods of stress determination including photoelasticity, stress coat and electric strain gauge techniques; stress analogies; strain rosettes for combined stress determinations. Prerequisite: E.Mch. 408 or 507. *Mr. Oppel*
507. THEORY OF ELASTICITY AND APPLICATIONS (3) Equations of equilibrium and compatibility; stresses and strains in beams, curved members, rotating discs, thick cylinders, torsion and structural members. Prerequisite: E.Mch. 13. *Mr. Hu*
508. THEORY OF ELASTIC STABILITY AND APPLICATIONS (3) Buckling of slender and short members; buckling of I-beams; stability of thin-walled constructions; thin-walled cylinders subjected to internal pressures; applications to structural parts including aircraft members. Prerequisites: E.Mch. 12, 13.
509. THEORY OF PLATES AND SHELLS (3) Bending and buckling of plates; elastic foundations; deformation of shells, multilayer shells, stress and stability analysis, weight optimization, application problems. Prerequisite: E.Mch. 13. *Mr. Oppel*
514. ENGINEERING MECHANICS SEMINAR (1 per term) Current literature and special problems in engineering mechanics.
516. MATHEMATICAL THEORY OF ELASTICITY (3) Fundamental equations and problems of elasticity theory; uniqueness theorems and variational principles; methods of stress functions and displacement potentials; applications. Prerequisite: E.Mch. 540. *Mr. Jaunzemis*

## ENGINEERING MECHANICS

520. **ADVANCED DYNAMICS (3)** Dynamics of a particle and of rigid bodies: Newtonian equations in moving coordinate systems; Lagrange's and Hamilton's equations of motion; special problems in vibrations and dynamics. Prerequisites: E.Mch. 12, Math. 44 or 431. *Mr. Davids*
522. **THEORY OF VIBRATIONS (3)** Mathematical theory of vibrating systems; damping phenomena; forced vibrations; analogy between mechanical and electrical vibrations; transverse and torsional oscillation of shafts; vibration of strings, beams, membranes, and plates. Prerequisites: E.Mch. 13, Math. 44 or 431. *Mr. Vierck*
523. **RELAXATION METHODS (3)** Relaxation methods compared to iteration and other numerical methods of analysis; application to elasticity, plasticity, stability, fluid flow, heat transfer, and related fields. Prerequisites: E.Mch. 13 or 111, Math. 44. *Mr. Vierck*
524. **MATHEMATICAL METHODS IN ENGINEERING (3 per unit)** Prerequisite: Math. 451 or E.E. 435 or M.E. 452. *Mr. Davids*  
*Unit A (3)* Basic concepts of tensors; matrices; numerical procedures; approximation; Fourier, Legendre, and other orthogonal series; applications; Bessel and other special functions.  
*Unit B (3)* Basic solutions of Laplace, diffusion, wave equations; boundary-value problems; Fourier, Laplace transforms; contour integration techniques; Cagnard's, energy methods.
526. **NONLINEAR MECHANICS (3)** Integral curves, singular points, self-sustained oscillations, stability problems, Hill's and Van der Pol's equation, mechanical and electrical applications. Prerequisite: E.Mch. 522. *Mr. Davids*
528. **EXPERIMENTAL METHODS IN VIBRATIONS (3)** Investigation of one or more degrees of freedom, free and forced mechanical vibrations, vibration properties of materials, vibration techniques in nondestructive testing. Prerequisite: E.Mch. 401 or 522. *Mr. Neubert*
529. **ENGINEERING APPLICATIONS OF SONICS (3)** Sound and ultra sound in engineering and science; principles, radiation, transducers, devices for sonic processing and testing. Prerequisite: Phys. 443.
530. **SOLID STATE MECHANICS (3)** Relation between solid state physics and mechanics; mechanical properties for static, fatigue, creep, and impact conditions; high temperature properties; applications. Prerequisite: E.Mch. 14. *Mr. Marin*
531. **THEORY OF PLASTICITY AND APPLICATIONS (3)** Yield condition; plastic stress-strain relations; theory of slip-line fields; applications to bending, torsion, axially symmetric bodies, metal processing. Prerequisite: E.Mch. 504 or 507. *Mr. Hu*
533. **DETERMINATION OF MECHANICAL PROPERTIES (3)** Experimental methods for determining hardness, elastic constants, creep behavior, fatigue strength, plastic flow, and dynamic properties of metals. Prerequisite: E.Mch. 14 or 530. *Mr. Hu*
534. **PHOTOELASTICITY (3)** Analysis of polariscopes; isoclinics, isochromatics, and stress trajectories; two- and three-dimensional photoelastic methods; determination of principal stresses; model preparation. Prerequisite: E.Mch. 408 or 507. *Mr. Oppel*
540. **MECHANICS OF CONTINUA (3)** Unified treatment of the theories of continuum mechanics: tensor analysis and kinematics of material media, dynamics, irreversible thermodynamics, constitutive equations. *Mr. Jaunzemis*
550. **STUDIES IN ENGINEERING MECHANICS (1-6)** Studies in any field of engineering mechanics.



## ENGLISH

PROFESSOR HENRY W. SAMS, *Head of the Department*  
245 Sparks Building

*Degrees Conferred:* Ph.D., D.Ed., M.A., M.Ed.

*Graduate Faculty:* Professors Bayard, Condee, Cramer, Frank, Lewis, Major, Peck, Rubin, Sams, Sutherland, and Young; Associate Professors Austin, Bauer, Bressler, Davis, Meserole, Morse, Reed, G. Smith, and Weintraub; Assistant Professors Hansen, Jewkes, and Oldsey.

A student may specialize in English literature, American literature, philology, or rhetoric. It is preferred that an entering student present 24 credits in English, but 18 credits in English exclusive of survey and freshman courses will be accepted. If the student does not present 18 credits in English, he must make up the deficiency early in his graduate work.

## ENGLISH (ENGL)

- |                                                          |                                                                                                            |
|----------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| 408. ADVANCED COLLEGE GRAMMAR (3)                        | <i>Miss McElwee</i>                                                                                        |
| 412. THE WRITING OF FICTION (3-6)                        | <i>Messrs. Rubinstein and Barth</i>                                                                        |
| 422. MASTERS OF BRITISH LITERATURE (3-6)                 |                                                                                                            |
| 423. HISTORY OF BRITISH LITERATURE (3)                   | <i>Mr. Major</i>                                                                                           |
| 432. MASTERS OF AMERICAN LITERATURE (3-6)                | <i>Messrs. Bressler, Davis, and Staff</i>                                                                  |
| 433. HISTORY OF AMERICAN LITERATURE (3)                  | <i>Messrs. Sutherland and Gidez</i>                                                                        |
| 434. MOVEMENTS IN AMERICAN LITERATURE (3-6)              | <i>Messrs. Hansen, Meserole, and Staff</i>                                                                 |
| 437. AMERICAN POETRY (3)                                 | <i>Messrs. Rubin and Hansen</i>                                                                            |
| 438. AMERICAN DRAMA (3)                                  | <i>Mr. Bauer</i>                                                                                           |
| 445. CHAUCER (3)                                         | <i>Mr. Frank</i>                                                                                           |
| 447. BRITISH POETRY FROM SKELTON TO DRYDEN (3)           | <i>Messrs. Reed and Smith</i>                                                                              |
| 448. ENGLISH DRAMA BEFORE SHAKESPEARE (3)                | <i>Mr. Jewkes</i>                                                                                          |
| 449. SHAKESPEARE: THE CHRONICLE AND PROBLEM PLAYS (3)    | <i>Messrs. Reed and Smith</i>                                                                              |
| 451. PROSE AND POETRY OF 18TH CENTURY ENGLAND (3)        | <i>Mr. Sams</i>                                                                                            |
| 455. THE NOVEL IN ENGLAND TO CHARLES DICKENS (3)         |                                                                                                            |
| 458. THE DRAMA FROM DRYDEN TO SHERIDAN (3)               | <i>Mr. Rogers</i>                                                                                          |
| 461. BRITISH PROSE OF THE 19TH CENTURY (3)               | <i>Mr. Cramer and Miss Austin</i>                                                                          |
| 462. WORDSWORTH AND COLERIDGE (3)                        | <i>Mr. Cramer and Miss Austin</i>                                                                          |
| 463. BYRON, SHELLEY, AND KEATS (3)                       | <i>Mr. Peck</i>                                                                                            |
| 465. VICTORIAN NOVEL (3)                                 | <i>Miss Austin</i>                                                                                         |
| 466. THE AMERICAN NOVEL TO 1900 (3)                      | <i>Messrs. Young and Oldsey</i>                                                                            |
| 467. VICTORIAN POETRY (3)                                | <i>Mr. Cramer</i>                                                                                          |
| 475. MODERN BRITISH FICTION (3)                          | <i>Mr. Sutherland</i>                                                                                      |
| 476. THE AMERICAN NOVEL SINCE 1900 (3)                   | <i>Messrs. Young and Lewis</i>                                                                             |
| 477. BRITISH AND AMERICAN POETRY OF THE 20TH CENTURY (3) | <i>Mr. Bauer</i>                                                                                           |
| 478. BRITISH AND IRISH DRAMA SINCE 1890 (3)              | <i>Mr. Weintraub</i>                                                                                       |
| 481. HISTORY OF ENGLISH LITERARY CRITICISM (3)           | <i>Messrs. Sams and Bressler</i>                                                                           |
| 488. MODERN CONTINENTAL DRAMA (3)                        | <i>Mr. Bauer</i>                                                                                           |
| 491. LITERATURE FOR TEACHERS IN SECONDARY SCHOOLS (3)    | <i>Mr. Bressler</i>                                                                                        |
| *499. ENGLISH INSTITUTE (6-12)                           | <i>Mr. Jewkes, Miss McElwee</i>                                                                            |
| 501. MATERIALS AND METHODS OF RESEARCH (3)               | Materials and techniques of research in English and American literary history; form and content of theses. |

\*A maximum of 6 credits in one summer.



## ENGLISH

Required of all graduate students with an English major.

*Messrs. Smith and Meserole*

521. OLD ENGLISH LANGUAGE (3) An introduction to the main features of the Old English language; readings in simple Old English prose and poetry. *Mr. Jewkes*
522. OLD ENGLISH LITERATURE (3) A reading of the more important poetic works in Old English; some reading in translation. *Mr. Jewkes*
540. STUDIES IN LITERATURE OF THE RENAISSANCE (3-6) *Messrs. Reed and Smith*
541. MEDIEVAL STUDIES (3) Seminar in special problems in medieval English literature. *Mr. Frank*
542. MIDDLE ENGLISH LITERATURE (3) Introduction to Middle English and its dialects; study of the literature of the period exclusive of Chaucer. *Mr. Frank*
543. STUDIES IN 17TH CENTURY LITERATURE (3-6) Topics will be drawn from any or all aspects of 17th century literature. *Mr. Condee*
544. RESTORATION LITERATURE (3) Selected studies of writers in England between 1650 and 1700.
545. CHAUCER (3) A critical study of the principal works of Chaucer; emphasis on literary backgrounds and exegesis. *Mr. Frank*
546. MILTON (3) The poetry and prose of John Milton. *Mr. Condee*
548. SHAKESPEARE'S CONTEMPORARIES AND IMMEDIATE SUCCESSORS IN DRAMA (3) *Mr. Jewkes*
549. SHAKESPEARE (3) Special problems of sources, chronology, text, characterization, and motivation in the drama. *Messrs. Reed and G. Smith*
552. THE AGE OF SWIFT (3) Special studies varying from year to year. *Mr. Sams*
553. THE AGE OF JOHNSON (3) The work of Johnson and his circle.
554. STUDIES IN AMERICAN LITERATURE TO 1812 (3) *Messrs. Meserole and Hansen*
561. STUDIES IN THE ROMANTIC MOVEMENT (3-6) *Messrs. Peck and Cramer*
562. STUDIES IN THE LITERATURE OF VICTORIAN ENGLAND (3-6) *Mr. Cramer and Miss Austin*
564. STUDIES IN AMERICAN LITERATURE, 1812 TO 1900 (3) The major figures treated will vary from year to year. *Messrs. Rubin, Davis, and Oldsey*
573. STUDIES IN CONTEMPORARY LITERATURE (3-6) *Messrs. Morse and Weintraub*
574. STUDIES IN AMERICAN LITERATURE SINCE 1900 (3) *Messrs. Young and Lewis*
581. CONTEMPORARY LITERARY CRITICISM (3) *Mr. Sams*
590. RESEARCH PROBLEMS IN ENGLISH (3-6) Methods of research in English, problems of bibliography, and method of evaluating sources and materials.
591. PROBLEMS IN AMERICAN LITERARY STUDY (3-6) *Messrs. Bressler, Davis, and Oldsey*
592. STUDIES IN AMERICAN LITERARY MYTH (3) An introduction to an interpretive, interdisciplinary study of some representative themes in American literature and culture. *Mr. Young*

593. ANGLO-AMERICAN FOLK SONG (3) Survey of relevant literary and ethnological scholarship and field work, European and American, from the early 16th century to the present. *Mr. Bayard*
595. STUDIES IN BRITISH FICTION (3) *Messrs. Sutherland and Peck*
596. STUDIES IN AMERICAN FICTION (3) *Messrs. Lewis and Young*
597. STUDIES IN AMERICAN POETRY (3) *Messrs. Rubin, Davis, and Hansen*

## ENTOMOLOGY

BERTIL G. ANDERSON

*Head of the Department of Zoology and Entomology*  
212 Frear Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors E. J. Anderson, Cheng, and Coon; Associate Professors Boyle and Rutschky; Assistant Professor Smyth.

A student majoring in entomology may specialize in apiculture, ecology, economic entomology, morphology, physiology, insect resistances of plants, taxonomy, or toxicology of insecticides.

For admission a student is required to have 24 credits in entomology or zoology and related biological sciences; and he should have had chemistry through organic chemistry. Courses in physics and mathematics are also advantageous. A limited deficiency may be made up, without degree credit, while pursuing graduate work.

### ENTOMOLOGY (ENT)

401. MEDICAL AND VETERINARY ENTOMOLOGY (3)
403. (Zool. 403) SYSTEMATICS (3) *Mr. Boyle*
405. INSECT MORPHOLOGY (3) *Mr. Rutschky*
413. ENTOMOLOGY SEMINAR (1 per term)
429. PRINCIPLES OF INSECT CONTROL (3)
431. ENTOMOLOGICAL PROBLEMS (1-6)
445. THE IDENTIFICATION OF INSECTS (3)
505. ADVANCED MORPHOLOGY OF INSECTS (3) Advanced work in either external or internal morphology of insects. Prerequisites: Ent. (Zool.) 403, Ent. 405. *Mr. Rutschky*
506. IMMATURE INSECTS (3) The morphology and taxonomy of the immature stages of insects. Prerequisite: 9 credits in entomology. Spring term, even years.
508. THE BIOLOGICAL CONTROL OF INSECTS (2) Artificial use of bacteria, fungous diseases, and animals in control of injurious insects; methods and equipment for rearing parasites and predators on a large scale. Prerequisites: Ent. 6, 8.
509. ENTOMOLOGICAL TECHNIQUE (2) For advanced students dealing with special methods of collecting, rearing living insects, preparing and preserving immature stages, keeping records, and preparing illustrations for manuscript. Prerequisite: Ent. 6. Fall term, odd years. *Mr. Coon*
514. ADVANCED SYSTEMATIC ENTOMOLOGY (1-10 per term) Taxonomy of various

## ENTOMOLOGY

orders of insects selected to meet the needs of the individual student. Prerequisites: Ent. (Zool.) 403, Ent. 405. *Mr. Boyle*

### 520. SPECIAL TOPICS (1-6)

528. INSECT PHYSIOLOGY (4) Normal functions of the insect body. Fall term, even years. *Mr. Smyth*

531. INSECT TOXICOLOGY (2) General principles of toxicology and survey of the actions of substances toxic to insects. Fall term, odd years. *Mr. Smyth*

540. INSECT RESISTANCE IN PLANTS (2) Mechanism, expression, permanence, and measurement of resistance to insects with special reference to farm crops. Spring term, odd years. *Mr. Coon*

## EXTENSION EDUCATION

EMORY J. BROWN

*Chairman of the Committee on Extension Education*  
205 Weaver Building

*Degrees Conferred: M.Agr., M.Ed.*

This program is designed primarily to meet the needs of professional teachers in various extension and adult education positions. The purpose is to train individuals to develop attitudes, understandings, and competencies which enable them to become more effective professional workers. Options have been developed for the Colleges of Agriculture and Home Economics. Additional options will be offered as they are developed by other Colleges.

Entrance requirements for an M.Ed. in this major include a minimum of 18 credits in education and 12 in the social sciences and a strong background in agriculture or home economics. Entrance requirements for the M.Agr. degree include a strong background in agriculture or home economics and a minimum of 12 credits in the social sciences.

For either degree a minimum of 30 credits is required, in addition to a professional paper. These credits should be distributed as follows: 12 credits in extension core courses, 6 in communication and/or education, and 12 in two areas of agriculture and/or home economics.

## FAMILY ECONOMICS AND HOME MANAGEMENT

MARJORIE M. KNOLL

*Head of the Department of Home Management, Housing, and Home Art*  
271 Home Economics South

*Degrees Conferred: Ph.D., D.Ed., M.S., M.Ed.*

*Graduate Faculty: Professors Harms, Hotchkiss, Knoll, Montgomery, and Wiesen-danger.*

In the graduate program family management practices, their effects upon members of the family unit, and the interaction of such practices with the local and national economy are studied in relation to principles of economics, philosophy, psychology, sociology, and political science.



## FAMILY ECONOMICS AND HOME MANAGEMENT

Those interested in emphasizing a study of home management, family economics, family housing, and home equipment may do so through this major. There are no specific course requirements for admission.

### CONSUMER SERVICE AND EQUIPMENT (CS EQ)

- 403. LECTURE-DEMONSTRATION TECHNIQUES (3)
- 413. HOME EQUIPMENT (3)
- 450. PROBLEMS IN HOUSEHOLD EQUIPMENT (1-6)

### FAMILY ECONOMICS AND HOME MANAGEMENT (FE HM)

- 415. HOUSEHOLD BUYING PRACTICES (3)
- 419. MANAGING FAMILY FINANCIAL RESOURCES (3)
- 423. (F.N. 423) FAMILY FOOD PURCHASING (2)
- 424. ECONOMIC CONDITIONS IN RELATION TO THE FAMILY (3)
- 439. MANAGEMENT PRINCIPLES IN HOME OPERATION (2)
- 442. RESIDENT EXPERIENCE IN HOME MANAGEMENT (3) Room and board will be charged at regular rates. *Miss Chennault*
- 445. HOME MANAGEMENT EXPERIENCE (3) *Miss Chennault*
- 477. FAMILY MANAGEMENT (3)
- 500. NONTHESIS RESEARCH (1-6) Nonthesis research problems.
- 515. CONSUMER PROBLEMS (2-3) Methods of securing, evaluating, and presenting data concerning household commodities. For home economics teachers in high schools, colleges, and adult classes. Prerequisites: F.E.H.M. 442, F.N. 220.
- 524. ECONOMIC PROBLEMS OF THE HOUSEHOLD (3) Economic problems of the present-day family; special emphasis on factors in household production, use of money income, and standards of living. Prerequisites: Econ. 14, F.E.H.M. 439.
- 528. HOME MANAGEMENT SUPERVISION (2-3) Evaluation of objectives and techniques in organization, supervision, and teaching of the home management house experience. Prerequisite: F.E.H.M. 439.
- 543. HOME MANAGEMENT IN RELATION TO FAMILY LIVING (3) Includes work with families in solution of their management problems. Prerequisites: F.E.H.M. 439, F.N. 220.
- 544. PROBLEMS IN FAMILY ECONOMICS AND HOME MANAGEMENT (1-6) Investigation of selected problems in family economics and home management. Prerequisite: 6 credits of family economics or home management courses in home economics.
- 550. SEMINAR IN FAMILY ECONOMICS AND HOME MANAGEMENT (1-6) Discussion and reports on developments in family economics and home management.

## FOOD SERVICE AND HOUSING ADMINISTRATION

S. EARL THOMPSON

*Head of the Department of Hotel and Institution Administration*

4A Home Economics Building

*Degrees Conferred:* M.S., M.Ed.

*Graduate Faculty:* Professors Atkinson and Thompson.

## FOOD SERVICE AND HOUSING ADMINISTRATION

Graduate work in this field trains for management positions in institutions which provide food service and housing to large groups, such as hospitals, residence halls, children's homes, and other public and private organizations. For admission, a student should have a baccalaureate degree in this or a related field.

### FOOD SERVICE AND HOUSING ADMINISTRATION (FS HA)

- 402. FOOD SERVICE AND HOUSING LAYOUT AND DESIGN (2)
- 410. ADVANCED QUANTITY FOOD PRODUCTION (3)
- 425. FOOD AND LABOR MANAGEMENT AND CONTROL (3)
- 461. INSTITUTION ADMINISTRATION (3)
- 470. PROBLEMS IN FOOD SERVICE AND HOUSING ADMINISTRATION (3)
  
- 502. PROBLEMS IN INSTITUTION ADMINISTRATION (3-6) Individual study of problems in institution administration. Prerequisites: F.S.H.A. 310, 330.  
*Miss Atkinson*

## FOODS AND NUTRITION

MIRIAM E. LOWENBERG, *Head of the Department*  
202B Home Economics Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., and M.Ed. in Foods and Nutrition; M.S. in Nutrition in Public Health.

*Graduate Faculty:* Professors Dodds, Gordon, Lowenberg, and Pike; Associate Professors Fuqua and Olson.

Graduate programs in foods and nutrition prepare students for careers in high school teaching, college teaching, research, and adult program leadership. The program in nutrition in public health prepares the student for work in public health agencies.

For admission to a graduate program in foods and nutrition, a student must have completed at least 9 credits in organic and inorganic chemistry, 3 in biological chemistry, 3 in bacteriology, 3 in physiology, 4 in other physical and biological sciences, and 8 in foods and nutrition.

For admission to the program in nutrition in public health, the requirements are at least 9 credits in organic and inorganic chemistry, 3 in biological chemistry, 3 in bacteriology, 12 in social sciences, 7 in foods, and 4 in nutrition.

### FOODS AND NUTRITION (F N)

- 400. SPECIAL PROBLEMS IN FOODS AND NUTRITION (1-3)
- 420. EXPERIMENTAL COOKERY (1-6)  
*Miss Olson*
- 421. CULTURAL AND AESTHETIC ASPECTS OF FOOD (3)  
*Mrs. Jennings*
- 422. SCIENTIFIC PRINCIPLES OF FOOD PREPARATION (3)  
*Miss Gordon*
- 423. (F.E.H.M. 423) FAMILY FOOD PURCHASING (2)
- 425. FOOD PRESERVATION (2)
- 426. RECENT DEVELOPMENTS IN FOODS (3)
- 452. ELEMENTS OF DIET IN DISEASE (3)  
*Miss Pike*
- 455. TEACHING NUTRITION TO BOYS AND GIRLS (3)
- 456. NUTRITION IN THE COMMUNITY (3)  
*Miss Lowenberg*
- 457. PRINCIPLES OF NUTRITION (3)  
*Miss Fuqua*
- 458. APPLIED NUTRITION (2)
- 459. ADVANCED NUTRITION (3)
- 490. FOODS AND NUTRITION SEMINAR (1)

## FOODS AND NUTRITION

520. READINGS IN FOODS (2) Critical review and reports of literature on selected food topics. *Miss Gordon*
521. SEMINAR IN FOODS (1-6) Discussion and reports on current research in the foods field. Prerequisite or concurrent: F.N. 520. *Miss Gordon*
522. ADVANCED EXPERIMENTAL FOODS (3) Experimental methods used in measuring the quality of foods; specific problems in food preparation. *Miss Gordon*
530. PROBLEMS IN FOODS AND NUTRITION (1-6)
531. ADVANCES IN FOODS AND NUTRITION (3) Recent findings in the related areas of foods and nutrition.
550. READINGS IN NUTRITION (3) Readings and reports of selected topics in nutrition. Prerequisite: F.N. 457.
551. SEMINAR IN NUTRITION (1-6) Selected topics and recent advances in nutrition.
552. NUTRITION IN DISEASE (3) Physiological and biochemical problems in metabolic diseases and the nutritional aspects of therapy. *Miss Pike*
553. NUTRITION OF CHILDREN (3) Nutritional needs of the normal child during prenatal life, infancy, and childhood. Prerequisites: A.B.Ch. 35, F.N. 457.
555. FIELD WORK IN NUTRITION (2-4) Field problems planned to meet the needs of individual students. Hours and problems to be arranged. *Miss Lowenberg*
556. THE SURVEY METHOD IN FOODS AND NUTRITION (2) Study of survey technique as a tool in the assay of food adequacy and nutritional status. *Miss Dodds*
557. INTERRELATIONSHIPS OF NUTRIENTS (2) Interrelationships of nutrients in the metabolic processes; their significance as applied to nutrition. *Miss Pike*

## FORESTRY

PETER W. FLETCHER  
*Director of the School of Forestry*  
102 Forestry Building

*Degrees Conferred:* M.S., M.F.

*Graduate Faculty:* Professors Bartoo, Chisman, Fletcher, Goddard, Humphrey, McDermott, Norton, Sharp, and White; Associate Professor Ward; Assistant Professors Gerhold, Murphey, Schemnitz, Sopper, and Tsoumis.

The graduate programs include two areas of technological inquiry, forest resource management and forest products; and two areas of scientific inquiry, forest science and wood science. The M.F. and M.S. degrees may be granted in the technological programs and the M.S. degree in the scientific programs.

Attention is called to the Ph.D. programs available in such related fields as agricultural economics, agronomy, botany, entomology, genetics and breeding, and plant pathology.

The technological area of forest resource management, which is concerned with planning and operation of the forest land complex, may include specialization in timber management, wildlife habitat management, watershed management, forest recreation, or a combination of all of these land use concepts within the framework of multiple objectives. An undergraduate degree in forest management or a similar



## FORESTRY

program emphasizing biological science, economics, and applied mathematics provides the preparation necessary for these specializations.

The technological area of forest products is concerned with the application of wood technology to the forest products industries with possible specialization in industrial management, quality control, and marketing. An undergraduate degree in wood utilization or a similar program emphasizing mathematics and basic engineering courses is prerequisite.

The forest science area is concerned with those disciplines fundamental to forest management, including forest ecology, wildlife ecology, forest economics, forest entomology, forest genetics, forest hydrology, forest pathology, forest soils, tree physiology, mensuration, and silviculture. An undergraduate degree in forestry or a comparable degree emphasizing mathematics and biological, chemical, and physical sciences is prerequisite.

The wood science area is concerned with the fundamentals of the structural, physical, mechanical, and chemical properties of wood. The student may specialize in wood anatomy, wood moisture relations, wood chemistry, wood adhesion, wood engineering, and pathological and entomological considerations of wood products. An undergraduate degree in wood utilization or its equivalent in mathematics and biological and physical sciences is prerequisite.

### FORESTRY (FOR)

- 421. REGIONAL SILVICULTURE (3)
- 427. FOREST RANGE MANAGEMENT (3)
- 445. IMPROVEMENTS (3)
- 450. DESIGN AND ANALYSIS OF EXPERIMENTS (3)
- 455. FOREST PHOTO INTERPRETATION (3)
- 466. FOREST MANAGEMENT AND MANAGEMENT PLANS (3)
- 469. PROBLEMS IN FORESTRY (1-9)
- 480. POLICY AND ADMINISTRATION (3)
- 481. FOREST WATERSHED MANAGEMENT (3)
- 491. LOGGING AND LUMBERING (3)
- 497. SMALL SAWMILLS (3)
  
- 504. RESEARCH METHODS IN FORESTRY (2-6 per term) Review of methods employed in conducting forestry research.
- 508. FOREST ECOLOGY (2-4) Organization, development, and classification of forest communities.
- 509. COVERT MANAGEMENT (2) Management of forest associations for maintenance and development of wildlife. Prerequisite: For. 508.
- 510. FORESTRY SEMINAR (1-2 per term) Current problems of forest research presented as weekly seminar reports. May be repeated with additional credit for each term's work.
- 550. FOREST MENSURATION (2-8 per term) Research in some chosen field. Prerequisite: For. 450.
- 560. FOREST MANAGEMENT (3-8) Special topics in forest management and research in some chosen field. Prerequisite: For. 466.
- 575. APPLICATIONS OF FOREST ECONOMICS AND FINANCE (3 per term) Survey of situations in forestry where business problems and particular circumstances of production, value, and costs are currently significant. Prerequisite: For. 70.
- 590. THE LUMBER INDUSTRY (2-4) Relation of the lumber industry to national economy and world trade; lumbermen's associations; lumber accounts.

591. PROBLEMS IN LOGGING AND LUMBERING (2-6) Research in some chosen phase of lumbering. Prerequisite or concurrent: For. 590.

### WOOD UTILIZATION (W U)

404. MECHANICAL PROPERTIES OF WOOD (3)  
 405. VENEER AND PLYWOOD (3)  
 424. (Bot. 424) COMMERCIAL TROPICAL WOODS (3)  
 431. PROBLEMS IN FOREST PRODUCTS (3-6)  
 435. SEASONING AND PRESERVATION (3)  
 437. ADVANCED WOOD TECHNOLOGY (3)  
 462. DEFECTS IN WOOD (3)  
 492. LUMBER DISTRIBUTION (3)  
 495. MILLING AND COSTS IN THE FOREST PRODUCTS INDUSTRIES (3)
502. WOOD FIBERS (3-5) Identification and physical and chemical characteristics of wood fibers used for pulp, either for paper or as a source of cellulose. Pulping quality, fiber measurements.
510. WOOD UTILIZATION SEMINAR (1-2 per term)
530. PROBLEMS IN WOOD UTILIZATION (3-6 per term) Prerequisite: W.U. 431.
531. STRUCTURAL USES OF WOOD AND WOOD PRODUCTS (3-6 per term) Wood as a construction material; testing techniques for structural timbers and wood assemblies; use of laminated wood, ring connectors, and other types of special construction. Prerequisite: W.U. 404.
532. LAMINATES (3-6 per term) Advanced and special studies in fabrication and use of plywood, laminated wood, paper-base laminates, and wood-to-metal bonding. Prerequisite: W.U. 405.
535. CONDITIONING TREATMENTS FOR WOOD (3-6 per term) Advanced study and problems in preservative, seasoning, and other special treatments for wood and wood products. Prerequisite: W.U. 435.

## FUEL TECHNOLOGY

HOWARD B. PALMER, *Head of the Department*  
 316 Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Given, Palmer, and Walker; Associate Professors Austin and Essenhigh; Assistant Professors Polansky and Vastola.

In their programs of courses and research, students may emphasize the chemical, physical, or engineering aspects of solid, liquid, or gaseous fuels. Students are accepted with undergraduate majors in chemistry, chemical engineering, mechanical engineering, physics, or fuel technology.

The department has special facilities for research on high temperature gaseous reactions; reactions of free radicals; combustion of pulverized coal and oil sprays; dust explosions; fuel cells; formation, structure, physical properties, and reactions of carbons and graphites; chemistry of coal macerals; reactions in plasmas; structure and reactions of coals; and special organic reactions of fuel-related materials.

Each student is encouraged to develop a strong minor in the field most closely related to his area of specialization in fuel technology.

## FUEL TECHNOLOGY

### FUEL TECHNOLOGY (F T)

400. FUEL TECHNOLOGY RESEARCH AND DESIGN (1-3)  
402. CHEMICALS FROM FUELS (2) *Mr. Given*  
405. COMBUSTION CALCULATIONS (3) *Mr. Austin*  
406. GASEOUS COMBUSTION (3) *Mr. Palmer*  
408. COMBUSTION AND GASIFICATION ENGINEERING (4) *Mr. Essenhight*  
409. COKES, CARBONS, AND GRAPHITES (2) *Mr. Polansky*  
410. FUEL TECHNOLOGY LABORATORY (2) *Mr. Polansky and Staff*  
414. FUEL ENGINEERING ANALYSIS (2) *Mr. Austin*  
415. NEW SOURCES OF ENERGY (2) *Mr. Vastola*
503. COALIFICATION AND COAL CHEMISTRY (3) Chemical changes during the coalification process; chemical and physical constitution and classification of coals; relations between coal chemistry and constitution. Prerequisite: Chem. 31. *Mr. Given*
506. KINETICS OF CARBON REACTIONS (3) Current approaches to heterogeneous reactions in combustion and gasification of coals and carbons. Prerequisites: Chem. 451, F.T. 409. *Mr. Walker*
510. SPECIAL TOPICS IN FUEL TECHNOLOGY (1-6 per term)
511. FUEL TECHNOLOGY SEMINAR (1 per term) Selected topics from current fuel technology research examined and discussed.
512. HIGH TEMPERATURE KINETICS AND FLAME PROPAGATION (3) Laminar and turbulent premixed and diffusion flames; gaseous detonations; rate processes in high temperature gases. Prerequisite: F.T. 406. *Mr. Palmer*
514. JET AND ROCKET FUELS (2) Propulsion systems; combustion chamber conditions; liquid and solid propellants, slurries, fuel sprays, and finely divided solids. Prerequisite: F.T. 406. *Mr. Palmer*
515. CATALYSIS OF FUEL REACTIONS (2) Principles of chemisorption and catalysis; mechanisms of specific catalytic reactions and practical aspects of catalytic processes in the fuels industries. Prerequisite: Chem. 452. *Mr. Walker*

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in fuel technology studies are listed under Mineral Sciences.*

## GENERAL FAMILY STUDIES

ROSE COLOGNE

*In Charge of Graduate Programs in General Family Studies*  
19D Home Economics Building

*Degrees Conferred: Ph.D., D.Ed., M.S., M.Ed.*

Because this program is planned for teachers in secondary schools or small colleges and others who wish to become proficient in several areas of home economics, the student must have a strong home economics background for admission.

The major for the M.S. or M.Ed. degree consists of a minimum of 6 credits in each of three areas of home economics. Three areas in this field are also the basis for the major at the doctoral level. However, the minimum credit requirements in each area are established after consultation with a committee which reviews all previous work. The student chooses a minor field of educational foundations or, if sufficient compe-



## GENERAL FAMILY STUDIES

tence in educational foundations is demonstrated, one of the applied fields, such as home economics education, secondary education, or higher education.

### GENERAL FAMILY STUDIES (G F S)

- 502, 502v. HOME ECONOMICS AND AMERICAN SOCIETY (3) Family life education in relation to a democratic culture; emphasis upon the interrelatedness of socio-economic problems and the American family.
503. GRADUATE SEMINAR IN HOME ECONOMICS (1) *Miss G. M. Henderson*
- 516, 516v. METHODS OF RESEARCH IN HOME ECONOMICS (3) Review of problems and techniques of research in home economics. Required of all graduate students in home economics. *Miss Ray and Mrs. Siegel*
530. SELECTED PROBLEMS IN GENERAL HOME ECONOMICS (1-6)

## GENETICS AND BREEDING

JAMES E. WRIGHT, *Chairman of the Committee on Genetics and Breeding*  
307 Buckhout Laboratory

*Degrees Conferred:* Ph.D., M.S.

Graduate programs are offered in the fields of theoretical and applied genetics. Courses in genetics and breeding are given by various departments. The basic and theoretical courses are listed under identical numbers in the Department of Botany and Plant Pathology and the Department of Zoology and Entomology. Courses dealing with genetic principles as applied to specific organisms are offered in the Departments of Agronomy, Animal Husbandry, Bacteriology, Horticulture, and Poultry Husbandry. The graduate committee for majors shall be appropriately represented by members of theoretical and applied phases who shall have the responsibility and jurisdiction for determining course work and research acceptable in satisfying degree requirements.

For entry as a major in this field no fewer than 15 credits in basic biology and 15 credits in the areas of chemistry, mathematics, and physics are required.

The following courses are available in genetics and breeding, and their descriptions may be found under the offerings of the several departments: Agro. 411, 509, 510, 582; A.H. 501, 505; Bact. 516; Bot. (Zool.) 405, 422, 505, 524, 528, 533; Hort. 444, 503, 520; P.H. 402, 505.

## GEOGRAPHY

E. WILLARD MILLER, *Head of the Department*  
202 Mineral Sciences Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Deasy, Griess, Lewis, Miller, and Rodgers; Assistant Professor Simkins.

Students may concentrate on physical geography, human geography, political geography, economic geography, cartography, or some aspect of regional geography.

Because physical geography is a branch of the physical sciences and human, political, and economic geography are branches of the social sciences, a student may enter

## GEOGRAPHY

graduate work under either of two options. Option 1, for the student who wishes to specialize in physical geography, requires the completion of 18 undergraduate credits in geography and 20 credits in mathematics and biological and physical sciences, including at least 6 credits in geology. Option 2, for the student who wishes to specialize in human, political, or economic geography, requires 18 undergraduate credits in geography plus 20 credits in the social sciences, including at least 3 in economics.

### GEOGRAPHY (GEOG)

- |                                                 |                      |
|-------------------------------------------------|----------------------|
| 400. REGIONAL GEOGRAPHY OF NORTH AMERICA (3)    | <i>Mr. Deasy</i>     |
| 405. GEOGRAPHY OF POPULATION AND SETTLEMENT (3) | <i>Mr. Simkins</i>   |
| 420. URBAN GEOGRAPHY (3)                        | <i>Mr. Rodgers</i>   |
| 427. REGIONAL GEOGRAPHY OF THE SOVIET UNION (3) | <i>Mr. Rodgers</i>   |
| 433. REGIONAL CLIMATOLOGY (3)                   | <i>Mr. Wernstedt</i> |
| 442. GEOGRAPHY OF EUROPE (3)                    | <i>Mr. Miller</i>    |
| 443. GEOGRAPHY OF THE ORIENT (3)                | <i>Mr. Wernstedt</i> |
| 444. GEOGRAPHY OF AFRICA (3)                    | <i>Mr. Smith</i>     |
| 452. INTERPRETATION OF AERIAL PHOTOGRAPHS (3)   | <i>Mr. Deasy</i>     |
| 460. POLITICAL GEOGRAPHY (3)                    | <i>Mr. Lewis</i>     |
| 480. GEOGRAPHY OF WORLD MANUFACTURING (3)       | <i>Mr. Miller</i>    |
| 490. PHYSICAL GEOGRAPHY FOR TEACHERS (3)        | <i>Mr. Lewis</i>     |
503. ADVANCED REGIONAL GEOGRAPHY (3-12) Intensive study at an advanced level of selected regions or sections of the continents. Prerequisite: 12 credits in geography.
504. PHYSICAL GEOGRAPHY SEMINAR (3-12) The literature of some phase of physical geography with emphasis on procedures for organizing material for classroom reports and discussions.
505. ECONOMIC GEOGRAPHY SEMINAR (3-12) The literature of some phase of economic geography with emphasis on procedures for organizing material for classroom reports and discussions.
506. CULTURAL AND POLITICAL GEOGRAPHY SEMINAR (3-12) The literature of some phase of cultural and political geography with emphasis on procedures for organizing material for classroom reports and discussions.
507. DEVELOPMENT OF GEOGRAPHIC THOUGHT (1-6) Critical analysis of the growth of geographic thought from antiquity to the present; emphasis on structure of modern geography.
510. PHYSICAL GEOGRAPHY RESEARCH (3-10) Original study in physical geography: a field problem or detailed library investigation with analysis and presentation of data.
511. ECONOMIC GEOGRAPHY RESEARCH (3-10) Original study in economic geography: a field problem or detailed library investigation with analysis and presentation of data.
512. CULTURAL AND POLITICAL GEOGRAPHY RESEARCH (3-10) Original study in cultural and political geography: a field problem or detailed library investigation with analysis and presentation of data.

## GEOLOGY

LAUREN A. WRIGHT, *Head of the Department*  
110 Mineral Sciences Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Jahns, Krynine, Ridge, Spackman, Swartz, and Wright; Associate Professors Burnham, Lattman, Scholten, and Williams; Assistant Professors Barnes, Schmalz, and Taylor.

Graduate work in this field offers opportunity for specialization in stratigraphy, paleontology, paleobotany, palynology, regional and structural geology, geomorphology, ground water geology, marine geology and chemical oceanography, coal geology, and geology of metallic and nonmetallic deposits.

Prerequisites for admission include 25 credits in an approved combination of chemistry, physics, mathematics, and biological sciences, and at least 18 credits in geology and mineralogy.

## GEOLOGICAL SCIENCES (G SC)

- |                                         |              |
|-----------------------------------------|--------------|
| 400. GEOLOGY FOR TEACHERS (3)           |              |
| 410. STRUCTURAL GEOLOGY (3)             |              |
| 420. PALEOBOTANY (3)                    | Mr. Spackman |
| 421. INTRODUCTION TO COAL PETROLOGY (3) | Mr. Williams |
| 422. INTRODUCTORY PALYNOLOGY (3)        |              |
| 430. PALEONTOLOGY (3)                   | Mr. Swartz   |
| 440. MARINE GEOLOGY (3)                 | Mr. Schmalz  |
| 451. ECONOMIC GEOLOGY (3)               | Mr. Ridge    |
| 452. INTRODUCTION TO HYDROGEOLOGY (3)   | Mr. Parizek  |
| 461. GEOLOGY OF THE UNITED STATES (3)   |              |
| 462. PRINCIPLES OF GEOMORPHOLOGY (3-6)  | Mr. Lattman  |
| 470. INTRODUCTION TO FIELD GEOLOGY (3)  | Mr. Jahns    |
| 472. FIELD GEOLOGY (5)                  | Mr. Scholten |
| 481. GEOLOGY OF OIL AND GAS (3)         | Mr. Scholten |
| 490. PALEOZOIC STRATIGRAPHY (3)         | Mr. Swartz   |
| 491. STRATIGRAPHY FIELD TRIPS (1)       | Mr. Swartz   |
| 492. PENNSYLVANIAN STRATIGRAPHY (3)     | Mr. Williams |

## GEOLOGY (GEOL)

- \*500. GEOLOGY SEMINAR (1-9) Presentation, at weekly departmental meetings, of topics selected from geological literature.
- †501. STRATIGRAPHY (3-12) Principles of stratigraphic classification, lithofacies and biofacies, faunal zonation, correlation, sedimentation, and paleogeography, illustrated by stratigraphy of classical geologic regions: (a) Pre-Cambrian; (b) Paleozoic; (c) Mesozoic; (d) Cenozoic. Prerequisite: G.Sc. 430. Mr. Swartz
- †503. PALEONTOLOGY (3-9) Morphology of animal groups significant for their fossils; nature of species and faunal zones. Seminars may be arranged for studies of special fossil groups, microfossils, paleoecology. Mr. Swartz

\*Credits to be arranged, 1 to 6 per term.

†Credits to be arranged, 3 to 6 per term.



## GEOLOGY

504. HISTORY AND FOUNDATIONS OF GEOLOGY (2-3) Development through the ages of scientific thought in the earth sciences. *Mr. Krynine*
507. SEMINAR IN GEOMORPHOLOGY (3-6) Classic and current literature in geomorphology. *Mr. Lattman*
511. ORE DEPOSITS: PRINCIPLES (3-6) Geological and geochemical processes controlling ore deposition; genetic classification of ore deposits. Prerequisite: G.Sc. 451. *Mr. Ridge*
512. ORE DEPOSITS: TYPES (1-6) Geologic history and field examination of selected ore bodies; forming media; causes, sequences, and loci of emplacement; wall rock alteration; secondary enrichment. Prerequisite: Geol. 511. *Mr. Ridge*
515. ORE MICROSCOPY (2-3) Theory and use of the ore microscope in identifying ore minerals in polished section, establishing paragenetic sequences, determining manner of deposition.
520. SEMINAR IN PALEOBOTANY (2-6) Current and classic literature concerning evolution, paleoecology, and geologic history of vascular plants. *Mr. Spackman*
524. COAL PETROLOGY (1-6) Microscopy, source materials, coalification, constitution, classification of peats, lignites, bituminous coal, anthracite. *Mr. Spackman*
526. PROBLEMS IN PALYNOLOGY (3-9) Systematics; paleoecological palynology; Paleozoic palynology; Mesozoic and Cenozoic palynology; Pleistocene vegetational history.
530. GEOLOGICAL PROBLEMS (3-6) Study, from the literature, of a selected geological problem. Prerequisite: 10 credits in geology and mineralogy.
540. CHEMICAL OCEANOGRAPHY (3) Chemical reactions in sea water and at the sea floor related to sedimentation and diagenesis. *Mr. Schmalz*
545. GLACIAL GEOLOGY (3) Glaciers: their characteristics, causes, deposits, land forms, effects in periglacial regions. *Mr. Lattman*
546. PRINCIPLES OF PHOTOGEOLOGY (3) Use of aerial photographs and mosaics in structural, geomorphic, and rock distribution studies and in compilation of maps. Prerequisites: G.Sc. 410, 462. *Mr. Lattman*
551. GEOTECTONICS (3-6) Tectonic principles and elements: nature and development of geosynclines, island arcs, mountain structures, stable masses, cratons, mobile belts. *Mr. Scholten*
555. ADVANCED STRUCTURE AND PETROFABRICS (1-3) Macroscopic and microscopic recognition, measurement, and interpretation of small-scale rock structures and mineral orientation patterns in deformed rocks.
571. HABITAT OF OIL (3) Geologic setting of petroleum as determined by basin tectonism, sedimentation, hydraulic and capillary forces, and reservoir textures. *Mr. Scholten*
590. GEOLOGY FIELD TRIP (1 per year) Field study of regional geologic features with trips in successive years to differing geologic provinces. Required each spring of all graduate students in geology.

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in geological studies are listed under Mineral Sciences.

# G E O P H Y S I C S   a n d   G E O C H E M I S T R Y

B. F. HOWELL, JR., *Head of the Department*  
220 Mineral Sciences Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Bell, Greig, Howell, Keith, Osborn, Roy, and Tuttle;  
Associate Professor Herzog; Assistant Professors Crowe, Dachille, and McKinstry;  
Mrs. Roy.

Graduate work is offered in the field of geophysics (geophysical prospecting, seismology, gravity, well logging, radioactive age determinations, tectonics, physical properties of rocks), in the field of geochemistry (crystal chemistry, phase equilibria, element distribution and affiliations, isotope geochemistry, geochemical prospecting, cosmochemistry, high-temperature and high-pressure geochemistry), and in the field of solid state technology (see page 164).

Before starting graduate study, an applicant is generally expected to have had (1) a standard introductory course in each of the following four subjects: chemistry, physics, geology, and mineralogy; (2) 12 semester hours of intermediate level work in any one or a combination of chemistry, physics, and geological science; and (3) mathematics through integral calculus (for geochemistry) or differential equations (for geophysics). Students who have taken somewhat less than the indicated minima in these subjects may be admitted, but must make up their deficiencies concurrently with their graduate studies.

## G E O L O G I C A L   S C I E N C E S   ( G   S C )

406. PHYSICS OF THE EARTH (3)	<i>Mr. Howell</i>
407. WELL LOGGING (3)	<i>Mr. Crowe</i>
408. GEOPHYSICAL SURVEYING (3)	<i>Mr. Crowe</i>
416. ELECTRICAL SURVEYING (2)	<i>Mr. Crowe</i>
417. SEISMIC SURVEYING (3)	<i>Mr. Howell</i>
418. POTENTIAL THEORY APPLIED TO EARTH PROBLEMS (3)	<i>Mr. Crowe</i>
426. GEOPHYSICS FIELD WORK (1-4)	<i>Messrs. Crowe and Lavin</i>
456. INTRODUCTORY GEOCHEMISTRY (3)	<i>Mr. Keith</i>
457. GEOCHEMICAL PROSPECTING (2)	<i>Mr. Barnes</i>
458. GEOCHEMISTRY OF AQUEOUS SYSTEMS (2)	<i>Mr. Barnes</i>

## G E O P H Y S I C S   A N D   G E O C H E M I S T R Y   ( G   G )

500. GEOPHYSICAL SEMINAR (1 per term) Discussion of geophysical reports and papers; scientific outlook.
501. RESEARCH (1-10 per term) Original research in geophysics or geochemistry.
502. SEISMIC INSTRUMENTS (3) Characteristics and design of seismometers and seismic recorders. *Mr. Howell*
503. SPECIAL STUDIES IN GEOPHYSICS (1-9) Special studies of the theories of geophysical methods.
507. SEISMOLOGY (3) Nature and transmission of seismic waves; cause and occurrence of earthquakes; applications in seismic prospecting. *Mr. Howell*
508. TECTONICS (3) Seminar in the cause and nature of the principal deformations of the earth. *Mr. Howell*
509. GEOCHEMISTRY SEMINAR (1 per term)



## GEOPHYSICS AND GEOCHEMISTRY

510. PROBLEMS IN GEOCHEMISTRY (1-9) Laboratory and library study of special problems.
512. INTRODUCTION TO HIGH-TEMPERATURE GEOCHEMISTRY (3) Ion configuration and radii; simple crystal structures; measurement and control of temperature and pressure; methods and principles of phase equilibrium determination. *Mr. Roy*
513. PHASE EQUILIBRIA IN MINERAL SYSTEMS I (2-3) Interpretation of phase-equilibrium diagrams with emphasis upon binary, ternary, and quaternary oxide systems at atmospheric pressure. *Mr. Osborn*
514. ELEMENT DISTRIBUTION IN THE EARTH (3) Principles and data from studies of phase equilibria, petrology, and crystal structure as related to distribution of elements in minerals, rocks, and the earth.
515. ELECTRIC WELL-LOGGING (2-3) Quantitative and qualitative methods of interpreting electrical resistivity, induction, and self-potential logs; comparison of electrical logging methods.
516. INTRODUCTION TO NUCLEAR PROCESSES IN GEOLOGIC SETTINGS (2) Natural radioactivity and its measurement, interpretation, and use in research and exploration. *Messrs. Herzog and Wright*
517. AGE DETERMINATIONS (1-2) Geochemistry of radioactive elements and their daughters; age determination techniques and observations. *Mr. Herzog*
518. ISOTOPE-RATIO VARIATIONS IN NATURE (2) Theoretical basis and observations of isotope fractionation in nature: paleotemperature scale; temperatures of formation of ore deposits and other rocks.
519. COSMOCHEMISTRY AND NUCLEOGENESIS (2) Distribution and composition of matter; origin of solar system and earth, of constituent nuclides, of life. *Mr. Herzog*
520. PHASE EQUILIBRIA IN MINERAL SYSTEMS II (2-3) Continuation of G.G. 513. Pressure as a variable; thermodynamic calculations and experimental methods pertaining to phase equilibrium diagrams. Prerequisite: G.G. 513. *Mr. Wyllie*

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in geophysical and geochemical studies are listed under Mineral Sciences.*

## GERMAN

PHILIP A. SHELLEY, *Head of the Department*  
229 Sparks Building

*Degrees Conferred:* Ph.D., M.A., M.Ed.

*Graduate Faculty:* Professors Adolf, Buffington, and Shelley; Associate Professors Beare, de Levie, Lüders, and Striedieck.

There is opportunity for major emphasis upon either literature or philology. Minimum qualifications for admission include 18 undergraduate credits in German; provision is made, however, for admission with limited deficiencies.

### GERMAN (GER)

401. ADVANCED STYLISTICS (3)

430. HISTORY OF THE GERMAN LANGUAGE (3)

*Mr. Buffington*



443. (C.Lit. 443) LITERARY RELATIONS OF GERMANY WITH ENGLAND AND AMERICA (3-9) *Mr. Shelley*
454. LITERATURE FROM THE AGE OF CHIVALRY TO THE THIRTY YEARS' WAR (3) *Miss Adolf*
464. LITERATURE FROM THE BEGINNING OF THE ENLIGHTENMENT THROUGH STORM AND STRESS (3) *Messrs. Buffington and de Levie*
469. GOETHE'S LIFE AND WORKS (3) *Messrs. Buffington and de Levie*
474. CLASSICISM AND ROMANTICISM (3) *Miss Adolf*
484. LITERATURE FROM REALISM TO EXPRESSIONISM (3) *Miss Lüders*
- \*1G. ELEMENTARY GERMAN FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees. *Messrs. Striedieck and de Levie*
- \*2G. ELEMENTARY GERMAN FOR GRADUATE STUDENTS (3) Continuation of Ger. 1G with opportunity for reading in special fields. *Messrs. Striedieck and de Levie*
500. BIBLIOGRAPHY AND RESEARCH TECHNIQUES (3) Introduction to tools and methods of research, designed for students preparing for independent investigation of problems in German literature and language. *Mr. Shelley*
531. MIDDLE HIGH GERMAN (3) Descriptive and historical grammar; reading and interpretation of texts. *Miss Adolf*
532. OLD HIGH GERMAN (3) Essentials of the grammar, with special treatment of the High German sound shift and of ablaut and umlaut; reading of works written before 1100 A.D. *Mr. Buffington*
533. GOTHIC (3) Essentials of the grammar; reading of Ulfilas' Bible translation. Suitable also for advanced students in English. *Miss Adolf*
541. SEMINAR IN THE LITERATURE OF THE REFORMATION AND BAROQUE (3) *Mr. Beare*
551. SEMINAR IN THE LITERATURE OF THE ENLIGHTENMENT AND THE AGE OF GOETHE AND SCHILLER (3-6) *Messrs. Buffington and de Levie*
561. SEMINAR IN POST-IDEALISTIC LITERATURE (3)
571. SEMINAR IN MODERN GERMAN LITERATURE (3) *Miss Lüders*
581. SEMINAR IN LITERARY GENRES (3-12) Special studies in the German lyric, drama, short story, and novel.
591. SEMINAR IN GERMAN LITERARY CRITICISM (3)

## HIGHER EDUCATION

HUGH S. BROWN, *in Charge of Graduate Programs in Higher Education*  
166 Chambers Building

*Degree Conferred: D.Ed.*

*Graduate Faculty: Professors Brown, Patrick, and Wellington.*

Graduate students with any undergraduate major may enter the program without other prerequisites. The following courses in higher education are listed under the offerings of the Department of Educational Services: Ed.Ser. 545 to 552 inclusive

\*No graduate credit is given for this course.

## HIGHER EDUCATION

and 555 (see page 93). To complete a program to meet the student's needs, additional courses will be selected from other departments of the University.

Candidates for advanced degrees in other fields may elect higher education as a minor, subject to the restrictions concerning minors.

## HISTORY

ROBERT K. MURRAY, *Head of the Department*  
116 Sparks Building

*Degrees Conferred:* Ph.D., D.Ed., M.A., M.Ed.

*Graduate Faculty:* Professors Brown, Dahmus, Forster, Gray, Klein, Murray, Pundt, and Rayback; Associate Professors DeNovo, Green, Hassler, Hoogenboom, McNall, and Thaden; Assistant Professor Pixton.

Graduate work is offered in the following fields of history: ancient, medieval, early modern European, modern European, colonial American, 19th century American, modern American, British, Russian, Latin American, Far Eastern, Middle Eastern, political (European or American), diplomatic (European or American), economic (European or American), social and cultural (European or American).

The candidate for the doctor's degree must pass examinations in four of the above fields, one of which is his dissertation field. He must also pass an examination either in a fifth field of history and a single cognate field, or in a study area made up of a number of academic disciplines related to his dissertation field. The candidate for the master's degree selects one broad field (such as modern European or American) for examination and thesis purposes. About half his course credits are selected outside the examination field. He also must take work in a cognate field.

The entering student should present evidence of undergraduate course work covering the history of Europe from ancient times to the present and the history of America from its discovery to the present.

### HISTORY (HIST)

- |                                                                         |                               |
|-------------------------------------------------------------------------|-------------------------------|
| 401. ANCIENT CIVILIZATION (3)                                           | Mr. Stagakis                  |
| 403. THE MIDDLE AGES FROM CONSTANTINE TO THE CRUSADES (3)               | Mr. Dahmus                    |
| 404. THE MIDDLE AGES FROM THE CRUSADES TO THE RENAISSANCE (3)           | Mr. Dahmus                    |
| 408. INTELLECTUAL HISTORY OF THE MIDDLE AGES (3)                        | Mr. Dahmus                    |
| 410. RENAISSANCE AND REFORMATION (3)                                    | Mr. Green                     |
| 413. THE AGE OF ABSOLUTISM (3)                                          | Mr. Green                     |
| 417. NINETEENTH CENTURY EUROPE (3)                                      | Messrs. Forster and Krantz    |
| 419. RECENT EUROPEAN HISTORY (3)                                        | Mr. Forster                   |
| 422. HISTORY OF THE AMERICAN FRONTIER (3)                               | Mr. McNall                    |
| 425. HISTORICAL BACKGROUND OF AMERICAN POLITICAL PARTIES, 1607-1900 (3) | Mr. Hoogenboom                |
| 427. THE DIPLOMATIC HISTORY OF THE UNITED STATES (3)                    | Mr. DeNovo                    |
| 428. AMERICAN MILITARY HISTORY (3)                                      | Mr. Hassler                   |
| 431. COLONIAL AND REVOLUTIONARY AMERICA (3)                             |                               |
| 432. THE FORMATIVE PERIOD OF AMERICAN HISTORY (3)                       | Mr. Brown                     |
| 433. THE MIDDLE PERIOD OF AMERICAN HISTORY (3)                          | Mr. Klein                     |
| 434. THE UNITED STATES IN CIVIL WAR AND RECONSTRUCTION (3)              | Mr. Hassler                   |
| 435. THE EMERGENCE OF MODERN AMERICA (3)                                | Messrs. Murray and Hoogenboom |
| 436. RECENT AMERICAN HISTORY (3)                                        | Mr. Murray                    |
| 440. HISTORY OF ENGLAND AND GREAT BRITAIN SINCE 1485 (3)                | Mr. Linker                    |
| 442. HISTORY OF RUSSIA TO 1861 (3)                                      | Mr. Thaden                    |

## HISTORY

- |                                                                      |                                             |
|----------------------------------------------------------------------|---------------------------------------------|
| 443. HISTORY OF MODERN RUSSIA (3)                                    | Mr. Thaden                                  |
| 444. EASTERN EUROPE IN MODERN TIMES (3)                              | Mr. Thaden                                  |
| 447. SOCIAL AND ECONOMIC HISTORY OF EUROPE SINCE 1750 (3)            | Mr. Pundt                                   |
| 448. INTELLECTUAL AND CULTURAL HISTORY OF MODERN EUROPE (3)          | Mr. Krantz                                  |
| 452. SOCIAL AND CULTURAL HISTORY OF THE UNITED STATES SINCE 1783 (3) | Mr. Brown                                   |
| 454. ECONOMIC DEVELOPMENT OF THE UNITED STATES (3)                   | Mr. McNall                                  |
| 456. HISTORY OF AMERICAN LABOR (3)                                   | Mr. Rayback                                 |
| 460. LATIN AMERICA AND THE UNITED STATES (3)                         | Mr. Gray                                    |
| 461. SOCIAL AND CULTURAL HISTORY OF LATIN AMERICA (3)                | Mr. Gray                                    |
| 471. HISTORY OF MODERN CHINA (3)                                     | Mr. Johnson                                 |
| 481. THE MIDDLE EAST IN MODERN TIMES (3)                             | Mr. Krantz                                  |
|                                                                      |                                             |
| 501. HISTORICAL METHOD (3)                                           | Mr. Klein                                   |
| 502. HISTORIOGRAPHY (3)                                              | Mr. Pundt                                   |
| 504. MEDIEVAL CIVILIZATION (3-9)                                     | Mr. Dahmus                                  |
| 505. THE AGE OF THE REFORMATION (3-6)                                | Mr. Green                                   |
| 508. STUDIES IN EUROPEAN HISTORY, 1600-1789 (3-6)                    | Mr. Pundt                                   |
| 509. EUROPE SINCE 1789 (3-6)                                         | Mr. Forster                                 |
| 512. STUDIES IN PENNSYLVANIA HISTORY (3-6)                           | Mr. Klein                                   |
| 520. COLONIAL AND REVOLUTIONARY AMERICA (3-6)                        |                                             |
| 533. THE UNITED STATES, 1783-1860 (3-6)                              | Mr. Klein                                   |
| 534. THE UNITED STATES, 1860-1900 (3-6)                              | Messrs. Brown and Hassler                   |
| 536. THE UNITED STATES IN THE 20TH CENTURY (3-6)                     | Messrs. Murray and Hoogenboom               |
| 538. DIPLOMATIC HISTORY OF THE UNITED STATES (3)                     | Mr. DeNovo                                  |
| 539. ECONOMIC HISTORY OF THE UNITED STATES (3)                       | Mr. McNall                                  |
| 540. STUDIES IN BRITISH HISTORY (3-6)                                |                                             |
| 545. STUDIES IN RUSSIAN AND SLAVIC HISTORY (3-6)                     | Mr. Thaden                                  |
| 550. PROBLEMS IN HISTORY (3-6)                                       |                                             |
| 562. SEMINAR IN LATIN-AMERICAN HISTORY (3-6)                         | Mr. Gray                                    |
| 563. STUDIES IN THE HISTORY OF THE CARIBBEAN AREA (3)                | Prerequisites: Hist.<br>22, 23.<br>Mr. Gray |
| 599. READINGS IN HISTORY (3)                                         |                                             |

## HOME ART

JAMES E. MONTGOMERY, *Professor of Housing and Home Art*  
250 Home Economics South

No advanced degree is offered in this field, but a candidate with a major in another field may choose a minor in home art upon approval by his major department.



## HOME ART

### FAMILY HOUSING AND HOME ART (FH HAR)

400. SPECIAL PROBLEMS IN HOME FURNISHINGS (3)

\*433. ADVANCED HOME CRAFTS (2-12)

440. HOME FURNISHING PROBLEMS (3)

447. HOME FURNISHINGS FOR THE FAMILY (3)

470. HOUSING THE FAMILY (2-3)

515. BACKGROUNDS OF THE HOME ARTS (3) Evaluation of useful objects in respect to their form, function, and time; selections for exhibition. Prerequisites: F.H.H.Ar. 216 or Art 15 or A.Ed. 106, and A.A.H. 1 or F.H.H.Ar. 240.

530. PROBLEMS IN HOME ART (1-6) Individual investigation, analysis, and presentation. Prerequisite: 6 credits in family housing and home art, art education, or art.

541. ART IN THE ENVIRONMENT (3) Approach based upon human needs with consideration of materials in the light of their use in home living. Prerequisite: Art 14 or A.Ed. 105 or F.H.H.Ar. 440.

## HOME ECONOMICS EDUCATION

MARJORIE EAST, *Head of the Department*  
116B Home Economics Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors East and Hatcher; Associate Professor Ray.

Research and graduate courses may be chosen to give emphasis to special areas of interest in home economics education, such as curriculum development; evaluation; teaching at the elementary, secondary, adult, or higher education levels; supervision; administration in colleges; or research.

For admission the student must present approximately 50 credits of undergraduate work from the following areas: home economics education, education and/or psychology, aspects of home economics; the physical and biological sciences; and the social sciences.

### HOME ECONOMICS EDUCATION (HE ED)

406, 406v. TEACHING AIDS IN FAMILY LIFE EDUCATION (1-4)

427, 427v. FAMILY LIFE EDUCATION (3)

443, 443v. ADULT HOMEMAKING EDUCATION (3)

463, 463v. SENIOR SEMINAR (2)

†466, 466v. STUDENT TEACHING (9)

478, 478v. APPRAISING STUDENT PROGRESS IN EDUCATION FOR FAMILY LIVING (3)

479, 479v. READINGS IN HOME ECONOMICS EDUCATION (1-4)

480, 480v. PRACTICUM IN TEACHING HOME ECONOMICS IN THE SECONDARY SCHOOL (3-6)

502, 502v. HOME ECONOMICS INSTRUCTION AT THE COLLEGE LEVEL (3) Teaching techniques suitable for college instruction in home economics; for prospective home economics college teachers.

*Mrs. East*

\*Not more than 2 credits in each field.

†A grade point average of 2.2 in all previous work is prerequisite to each course in student teaching.

## HOME ECONOMICS EDUCATION

- 503, 503v. PROBLEMS IN HOME ECONOMICS TEACHER EDUCATION (3) Organization of college programs of teacher education; use of resources; records; field services; recruitment and selection of personnel. Prerequisite: two years' experience in teaching home economics. *Miss Hatcher*
- 504, 504v. CURRENT DEVELOPMENTS IN EDUCATION IN RELATION TO HOME ECONOMICS (3) Opportunity for home economists to study newer developments in education. Prerequisite: one year's teaching experience in home economics. *Mrs. East*
- 509, 509v. CURRICULUM WORKSHOP IN FAMILY LIFE EDUCATION (3) Laboratory course in problems of curriculum building; individual problems in this field; frequent individual and group conferences. Prerequisite: one year's experience in teaching home economics. *Mrs. East or Miss Hatcher*
- 510, 510v. EDUCATIONAL LEADERSHIP IN HOME ECONOMICS (2-6) Principles of educational leadership for home economists preparing for administration; supervision of city and state programs; supervision of student teachers. Prerequisites: graduation from a four-year teacher education curriculum and two years' teaching experience in home economics. *Mrs. East*
- 518, 518v. EVALUATION IN FAMILY LIFE EDUCATION (3) Methods of evaluating progress toward goals in home economics education and use of findings in program planning and revision. *Miss Hatcher*
- 521, 521v. HOME ECONOMICS EDUCATION SEMINAR (2-3) Selected topics and recent developments in education for family living. Conferences and guidance relative to individual research problems.
- 526, 526v. THE COMMUNITY PROGRAM IN FAMILY LIFE EDUCATION (2-3) Ways of discovering community needs and resources; methods of developing the community program in family living; leadership education for the lay member of the community.
- 530, 530v. PROBLEMS IN HOME ECONOMICS EDUCATION (1-6 per term) Individual investigation of problems related to the teaching, supervision, or administration of home economics education.

## HORTICULTURE

DARRELL E. WALKER, *Acting Head of the Department*  
106 Tyson Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Fleming, Hitz, Larson, Mastalerz, Meahl, and Odland; Associate Professors McArdle, Ritter, Smith, Tukey, and Walker; Assistant Professors Bergman, Creech, and Pfahl.

Students may specialize in propagation, production, processing, breeding, nutrition, and other physiological studies of horticultural crop species, and in landscape design.

Prerequisites for major work in horticulture vary according to area of specialization; but basic courses in chemistry, mathematics, and the biological sciences are required. In addition, for students who wish to specialize in landscape architecture, basic courses in art and architecture and at least 30 credits in landscape architecture are required. Students who lack prerequisite courses may be admitted but are required to fulfill deficiencies without degree credit.

## HORTICULTURE

### HORTICULTURE (HORT)

412. STORAGE OF HORTICULTURAL CROPS (3) *Mr. Ritter*  
424. ADVANCED OLERICULTURE (3-6) *Mr. Odland*  
425. ADVANCED FRUIT AND VEGETABLE PROCESSING I (3) *Mr. McArdle*  
426. ADVANCED FRUIT AND VEGETABLE PROCESSING II (3) *Mr. McArdle*  
427. ADVANCED FLORICULTURE (3) *Mr. White*  
428. ADVANCED FLORICULTURE (3) *Mr. Mastalerz*  
444. ADVANCED PLANT BREEDING (3-6) *Mr. Walker*  
447. PROBLEMS IN HORTICULTURE (1-9)  
453. NURSERY PRINCIPLES AND PRACTICE (3) *Mr. Meahl*  
456. PROBLEMS IN NURSERY PRACTICE (3) *Mr. Meahl*
500. ECOLOGY OF FRUIT PLANTS (3) Factors limiting the distribution and intensity of culture of fruit species and varieties and effect of environmental factors on cultural practices. Spring term, even years. *Mr. Tukey*
501. EXPERIMENTAL PROBLEMS IN POMOLOGY (2-12) Investigation of problems involving review of literature, field and laboratory research. *Mr. Hitz*
503. EXPERIMENTAL PLANT BREEDING (2-12) Problems based mainly on research work of the department, with review of experimental methods and literature. Prerequisite: Hort. 444. *Mr. Walker*
504. EXPERIMENTAL PROBLEMS IN OLERICULTURE (2-9) Investigation of problems involving review of literature, field and laboratory research. Prerequisite: Hort. 424. *Mr. Odland*
505. PROBLEMS IN VEGETABLE PRODUCTION (2-6) Methods used in the more valuable contributions to vegetable production. Prerequisite: Hort. 424. *Mr. Odland*
506. NUTRITION OF HORTICULTURAL CROPS (2-4) Principles, applications, and interpretations of diagnostic methods for determining fertilizer requirements of horticultural crops. *Mr. Smith*
512. PRINCIPLES OF FRUIT AND VEGETABLE STORAGE (2-4) Principles involved in the maturation, storage, and senescence of fruits and vegetables, and their application. Winter term, odd years. *Mr. Ritter*
513. EXPERIMENTAL PROBLEMS IN ORNAMENTAL HORTICULTURE (2-12) Review of research in ornamental horticulture, with original investigations. *Mr. Meahl*
514. PROPAGATION OF ORNAMENTAL AND FRUIT PLANTS (3) Factors affecting the asexual and sexual propagation of fruit and ornamental plants. *Mr. Meahl*
517. HORTICULTURE SEMINAR (1 per term) Review of current research publications in horticulture. Each student presents one or more reviews of assigned topics.
519. SEMINAR ON THE GENETICS OF HORTICULTURAL CROPS (1 per term) Review of current research publications on the genetics of horticultural crops. Each student presents one or more reviews of literature on assigned topics.
520. SEMINAR ON THE BREEDING OF HORTICULTURAL CROPS (1 per term) Each student presents one or more reviews of literature on assigned topics.
523. PROPAGATION AND IMPROVEMENT OF VEGETABLE AND FLOWER CROPS (3) Methods and special techniques in breeding of flowers and vegetables; maintenance of seed stocks and seed production. Prerequisite: Hort. 444. Fall term, even years. *Mr. Odland*



## HORTICULTURE

524. EXPERIMENTAL PROCEDURES IN HORTICULTURAL RESEARCH (3)
525. HORTICULTURAL RESEARCH TECHNIQUES (3) Practice in and comparison of methods and apparatus used in horticultural research. Winter term, even years. *Mr. Tukey*
526. EXPERIMENTAL PROBLEMS IN FLORICULTURE (2-12) Greenhouse research and review of literature. Prerequisite or concurrent: Hort. 427, 428. *Mr. Mastalerz*
527. EXPERIMENTAL PROBLEMS IN NUTRITION OF HORTICULTURAL CROPS (2-12) Review of current research; problems for independent investigation. *Mr. Smith*
528. PROBLEMS IN FRUIT AND VEGETABLE PROCESSING (2-12) *Mr. McArdle*

## LANDSCAPE ARCHITECTURE (L ARCH)

- 425-426. LANDSCAPE CONSTRUCTION PROBLEMS (3 each) *Mr. Wilson*
427. LANDSCAPE CONSTRUCTION PROBLEMS (2) *Mr. Wilson*
434. (Rc.Ed. 434) RECREATION AREAS AND FACILITIES (3) *Mr. Wilson*
- 454-455-456. LANDSCAPE DESIGN (3 each) *Mr. Miller*
- 460-461-462. ADVANCED LANDSCAPE DESIGN (4 each) *Mr. Polakowski*
471. PARK DESIGN AND ADMINISTRATION (2-4) *Mr. Wilson*
472. SITE PLANNING OF INSTITUTIONAL AND PUBLIC PROJECTS (2) *Mr. Miller*
473. SITE PLANNING OF INSTITUTIONAL AND PUBLIC PROJECTS (2) *Mr. Miller*
518. ADVANCED PROBLEMS IN LANDSCAPE DESIGN (2-12) Selected problems for original investigation in the design, construction, and maintenance of landscape architectural projects. Prerequisite: L.Arch. 456.
521. TECHNICAL LANDSCAPE ARCHITECTURAL PRACTICES (2-12) Specific technical and professional problems in landscape architectural planning and practice. Prerequisites: L.Arch. 462, 471.

## INDUSTRIAL ARTS EDUCATION and VOCATIONAL INDUSTRIAL EDUCATION

S. LEWIS LAND, *Head of the Department of Industrial Education*  
245 Chambers Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Land and Williams; Associate Professors Pendered, Shemick, and Schaefer.

Emphasis may be placed on preparation for teaching, supervision, administration, or teacher education. Graduation from an approved curriculum in industrial arts or in vocational industrial education is required for admission to the respective fields.

## INDUSTRIAL ARTS (I ART)

400. SHOP MANAGEMENT AND LAYOUT (3)
407. CURRICULUM MATERIALS AND METHODS IN INDUSTRIAL ARTS (4)
470. PROBLEMS IN SENIOR HIGH SCHOOL INDUSTRIAL ARTS (3)

## INDUSTRIAL ARTS EDUCATION

574. HISTORY AND PHILOSOPHY OF INDUSTRIAL ARTS (2-3) Historical developments and concurrent educational philosophies of industrial arts in American education. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.
575. PROBLEMS IN INDUSTRIAL ARTS EDUCATION (2-3) Subject matter, projects, methods of manual and informational teaching, aids and devices, selection of text and reference materials, personnel organization, shop management, problem pupils. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.
576. SUPERVISION AND ADMINISTRATION OF INDUSTRIAL ARTS EDUCATION (2-3) How to organize, supervise, and administer functioning programs of industrial arts; duties of a supervisor and director of industrial arts. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.
577. TESTING IN INDUSTRIAL ARTS (2-3) Construction of informal manipulative and written tests; use of standardized mechanical aptitude and achievement tests; construction and use of rating scales; scoring and grading; interpretation of test results. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.
578. RESEARCH IN INDUSTRIAL ARTS (2-3) Research techniques in industrial arts education. Prerequisite: 6 credits in professional courses in industrial arts.
580. SEMINAR IN INDUSTRIAL ARTS (2-9) Directed intensive study, investigation, or research in selected phases of the program; reports and constructive criticism. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.

## INDUSTRIAL EDUCATION (I ED)

- 402v. SUPERVISION OF VOCATIONAL EDUCATION (3)
- 403v. SUPERVISED FIELD WORK (6)
- 408v. OCCUPATIONS (3)
- 409v. TESTS AND MEASUREMENTS (3)
- 412v. SPECIAL PROBLEMS IN VOCATIONAL EDUCATION (4)
- 415v. PROBLEMS IN COORDINATING VOCATIONAL EDUCATION (3)
- 420v. OCCUPATIONAL HYGIENE (3)
- 427v. ADVANCED COURSE OF STUDY BUILDING (3)
- 446v. IMPROVEMENT OF INSTRUCTION IN VOCATIONAL EDUCATION (4)
- 450v. SHOP LAYOUT AND MANAGEMENT (3)
- 501v. SEMINAR IN VOCATIONAL EDUCATION (6) Conferences, investigations, and discussion for advanced students and mature persons who have had experience as teachers, supervisors, or administrators.
- 506v. ADMINISTRATION OF VOCATIONAL EDUCATION (3) The job of the local director of industrial education in organizing and developing city and other local programs of industrial education. Prerequisite: 6 credits in industrial education, valid director's certificate, or equivalent training and experience.
- 510v. VOCATIONAL EDUCATION FOR ADMINISTRATORS (3) Designed for school administrators and supervisors who desire an understanding of practical arts and vocational education. Prerequisite: I.Ed. 1v or trade or teaching experience.
- 550v. RESEARCH IN VOCATIONAL EDUCATION (3) Research techniques in vocational industrial education.

## INDUSTRIAL ARTS EDUCATION

- 558v. EMERGING PROBLEMS IN INDUSTRIAL AND TECHNICAL EDUCATION (2-3 per unit)  
*Unit A. Federal Legislation* (2-3) Recent federal legislative activities and executive orders that bear directly and indirectly upon industrial education.  
*Unit B. Present-Day Local, Personnel, and Curriculum Problems* (2-3) Various plans, techniques, and practices.  
*Unit C. State and Local Supervision and Administration* (2-3) The more important recent problems in organization, supervision, and administration.  
*Unit D. Vocational Technical Education* (2-3) Problems of organization and administration of programs of technical education at the secondary and post-secondary levels. Prerequisite: 6 credits in industrial education, valid director's certificate, or equivalent training and experience.
- 560v. PHILOSOPHY OF INDUSTRIAL EDUCATION (3) Principles and beliefs of progressive industrial education; literature for evaluating instructional practices. Prerequisite: 12 credits in industrial education or teaching experience.

## INDUSTRIAL ENGINEERING

BENJAMIN W. NIEBEL, *Head of the Department*  
203 Engineering C

*Degrees Conferred:* M.S., M.Eng.

*Graduate Faculty:* Professors Niebel, Thuring, Draper, and Raphael.

Graduate study and research are conducted in operations research, linear programming, queuing theory, and experimental design. Opportunities also exist for advanced study in automation, production engineering, product design for production, work measurement, costs and budgets, tool design, methods analysis, personnel management, and management controls.

For admission a student must have graduated from an accredited school with a major in industrial engineering. Graduates of other accredited engineering curriculums may be admitted after completing 27 credits in industrial engineering.

### INDUSTRIAL ENGINEERING (I E)

- |                                                        |                                                          |
|--------------------------------------------------------|----------------------------------------------------------|
| 400. ENGINEERING FOR PRODUCTION (3)                    | <i>Mr. Niebel</i>                                        |
| 402. ENGINEERING ECONOMY (3)                           | <i>Messrs. Moss, Raphael, and Guild</i>                  |
| 404. MANAGEMENT SCIENCE (3)                            | <i>Messrs. Caldwell and Raphael</i>                      |
| 406. FACTORY PLANNING (2)                              | <i>Messrs. Thuring, Draper, and Raphael</i>              |
| 422a,b,c,d,e,f. INDUSTRIAL ENGINEERING PROBLEMS (2-12) | <i>Messrs. Niebel, Thuring, Moss, Guild, and Addison</i> |
| 423. QUALITY CONTROL (2)                               | <i>Messrs. Thuring and Moss</i>                          |
| 424. JOB EVALUATION (3)                                |                                                          |
| 425. METHODS OF INDUSTRIAL OPERATIONS RESEARCH (3)     | <i>Mr. Guild</i>                                         |
| 426. INDUSTRIAL AUTOMATION (3)                         | <i>Mr. Bowman</i>                                        |
| 427. ADVANCED METAL CASTING (3)                        | <i>Mr. Draper</i>                                        |
| 428. FOUNDRY ENGINEERING (3)                           | <i>Mr. Draper</i>                                        |
| 429. PLASTIC WORKING OF METALS (3)                     | <i>Mr. Bowman</i>                                        |
| 430. INDUSTRIAL LEADERSHIP (3)                         | <i>Mr. Caldwell</i>                                      |
| 432. INDUSTRIAL ENGINEERING LECTURES (1-3)             |                                                          |
501. MANUFACTURING METHODS (2-8) Special projects including investigation; experimentation, design, and research of one or more special types of manufacture.  
*Messrs. Niebel, Thuring, and Draper*



## INDUSTRIAL ENGINEERING

502. MANAGEMENT METHODS (3-6) Scientific management, including management controls and mathematical programming; research on special problems.  
*Messrs. Thuring and Raphael*
503. PERSONNEL RELATIONS (2-8) Research on special topics.  
*Messrs. Williamson and Addison*
505. GRAPHICAL COMPUTATION (2-6) Construction of natural and logarithmic scales, applications of various coordinate papers and construction of nomographic or alignment charts; determination of empirical formulae from engineering data.  
*Mr. Thuring*
506. TIME AND MOTION STUDY (3-9) Methods of research in motion and time study; critical analysis of current literature.  
*Mr. Niebel*
507. BUDGETARY CONTROL AND STANDARD COSTS (3-6) Divisional budgets as control media; establishing standard cost data, standard cost accounting procedures, and use of cost variances in controlling manufacturing operations. Prerequisite: I.E. 335.
513. DATA PROCESSING AND PROGRAMMING (3) Theory and techniques in systems analyses applied to the programming of procedures and operations.

## JOURNALISM

ROBERT M. POCKRASS, *Chairman of the Graduate Program*  
211 Carnegie Building

*Degree Conferred: M.A.*

*Graduate Faculty:* Professors Brown and Marbut; Associate Professors Froke, Hicks, and Pockrass; Assistant Professors Harrison and Norris.

The program is designed to give students a critical insight into the theory and practice of communication and the mass communications industries, as well as an introduction to research on communications problems. Fulfilling the requirements for this degree should qualify students to advance in positions of responsibility and leadership in the professions of journalism, advertising, broadcasting, and public relations; in communications research; or in education.

The program is designed for students who have a groundwork of technical and professional education or experience in journalism and communications. Such students are admitted under Plan A. Students lacking a knowledge of the fundamentals of journalism and communications may enroll under Plan B and be required to take up to 18 credits in basic courses needed to make up this deficiency.

### JOURNALISM (JOURN)

401. CRITICS AND ETHICS OF THE MASS MEDIA (2) *Mr. Harrison*
405. COMPARATIVE FOREIGN JOURNALISM (2)
421. EDITORIAL INTERPRETATION (3)
422. CULTURAL ASPECTS OF THE MASS MEDIA (3) *Mr. Pockrass*
424. PUBLIC AFFAIRS REPORTING (4) *Mr. Dulaney*
430. JOURNALISM IN THE SCHOOLS (3-6) *Mr. Vairo*
441. ADVANCED ADVERTISING COPYWRITING (3)
443. ADVERTISING CAMPAIGNS (3)
444. ADVERTISING IN CONTEMPORARY SOCIETY (3) *Mr. Norris*
466. PUBLIC RELATIONS PROBLEMS (3)

468. LAW OF MASS COMMUNICATIONS (3) *Mr. Marbut*  
 480. MEDIA MANAGEMENT (3)  
 485. COMPARATIVE THEORIES OF PRESS SYSTEMS (3) *Mr. Norris*  
 492. (Brcst. 492) PUBLIC AFFAIRS BROADCASTING (3) *Mr. Froke*  
 499. INDEPENDENT STUDY IN MASS COMMUNICATIONS (2-6) *Mr. Goodwin*
504. SEMINAR IN THE HISTORY OF MASS COMMUNICATION (3) *Mr. Marbut*  
 505. INTERNATIONAL COMMUNICATION PROBLEMS (3) Legal and communications problems of the international flow of news and opinion; international press codes.  
 506. SEMINAR IN COMMUNICATIONS RESEARCH (3-6) Methodology of research in media, content, audiences; experimental, case, and field studies; data processing and analysis; report writing; individual projects.  
 508. THE LITERATURE OF JOURNALISM (3) *Mr. Brown*  
 513. CURRENT PROBLEMS IN NEWS REPORTING AND EDITING (3) Securing, writing, display, and treatment of the news; newsroom policies and ethics. *Mr. Marbut*  
 521. NEWS MEDIA AND PUBLIC OPINION (3) Problems in the function, techniques, and responsibilities of press, radio, and television in forming and interpreting opinion. Prerequisite: Pl.Sc. 427, Psy. 429, or Soc. 431. *Mr. Pockrass*  
 540. SEMINAR IN ADVERTISING PROBLEMS (3)

## MATHEMATICS

JAMES B. BARTOO, *Head of the Department*  
 230 McAllister Building

*Degrees Conferred:* Ph.D., D.Ed., M.A., M.Ed.

*Graduate Faculty:* Professors R. Ayoub, Bartoo, Benton, Curry, Orrin Frink, Evan Johnson, Kanwal, Kasch, Krall, Mitchell, Ribeiro, Schoenfeld, and Sheffer; Associate Professors C. Ayoub, Aline Frink, Harkness, D. G. Johnson, Kist, Mack, Mary McCammon, Mrowka, Pervin, and Pour-El; Assistant Professors Barnes, Howard, Rabenstein, and Stevens.

Graduate courses in all the principal branches of mathematics are offered each year. The department is prepared to direct research in a variety of fields, including function theory, abstract algebra, topology, number theory, statistics, numerical analysis, and all aspects of mathematical logic and foundations. A digital computer is available on the campus for students interested in numerical methods.

To be admitted to the M.A. or Ph.D. program without undergraduate deficiency, an applicant should have completed at least 3 courses in mathematics at the advanced undergraduate level (400 series) or their equivalents. The undergraduate student is urged to take at least 6 credits in foundations of analysis (Math. 420-421) and 6 in modern algebra (Math. 480-481) or their equivalents. These courses are essential to prepare for the graduate program and, if they are taken after admission, only 6 credits at most may be counted toward an advanced degree.

To be admitted to the M.Ed. program without undergraduate deficiency in mathematics, an applicant should have at least 24 credits in mathematics including at least 6 at the intermediate level beyond calculus.

## MATHEMATICS (MATH)

403. MODERN METHODS IN GEOMETRY (3)



## MATHEMATICS

- 404. THEORY OF NUMBERS (3)
- 405. FOURIER SERIES AND BOUNDARY VALUE PROBLEMS (3)
- 407. FOUNDATIONS OF ALGEBRA AND GEOMETRY (3)
- 409-410. PROBABILITY AND STATISTICS (3 each)
- 411. FINITE DIFFERENCES (3)
- 412. ALGEBRAIC EQUATIONS (3)
- 413-414. MATHEMATICS OF SCIENCE FOR TEACHERS (3 each)
- 415. SURVEY OF MODERN MATHEMATICS FOR TEACHERS (3)
- 416. MATHEMATICAL LOGIC FOR TEACHERS (3)
- 417. VECTOR AND TENSOR ANALYSIS (3)
- 419. ANALYTICAL MECHANICS (3)
- 420-421. INTRODUCTION TO ANALYSIS (3 each)
- 428. (Phil. 428) LOGICAL THEORY (3)
- 431. DIFFERENTIAL EQUATIONS (3)
- 441. MATRIX ALGEBRA (3)
- 451-452. INTRODUCTION TO APPLIED MATHEMATICS (3-6 each)
- 453. MATHEMATICS FOR DIGITAL COMPUTERS (3)
- 472. FOUNDATIONS OF GEOMETRY (3)
- 473. ELEMENTS OF SET THEORY AND TOPOLOGY (3)
- 480-481. INTRODUCTION TO MODERN ALGEBRA (3 each)
- 491. TOPICS IN APPLIED MATHEMATICS (3-9)
  
- 500. ANALYTICAL MECHANICS (3) An exposition of rigid dynamics, the potential function, and Lagrange's equations. Prerequisite: Math. 419 or Phys. 461.
- 501-502. THEORY OF FUNCTIONS OF A REAL VARIABLE (3 each) Theory of real functions, sets, measure, derivatives, and integrals. Prerequisite: Math. 420.
- 503. FOURIER ANALYSIS (3) Fourier series and integrals, convergence and summability, theorems on Fourier coefficients, uniqueness properties. Prerequisite or concurrent: Math. 502.
- 505. INTEGRAL EQUATIONS (3) Fredholm and Volterra equations, and applications. Prerequisite: Math. 421.
- 507. CALCULUS OF VARIATIONS (3) Prerequisites: Math. 44, 421.
- 508-509. THEORY OF FUNCTIONS OF A COMPLEX VARIABLE (3 each) Development of the complex number system; theory of analytic functions. Prerequisite: Math. 421.
- 510. THEORY OF GROUPS (3) Selected topics from group theory including Abelian, solvable, nilpotent, and free groups, Sylow theorems, and group extensions and representations. Prerequisite: Math. 535.
- 511. LINEAR ALGEBRA (3) Vector spaces and linear transformations, canonical representations, elementary divisors and invariant factors. Prerequisites: Math. 480, 441; or Math. 481.
- 513-514. ADVANCED ANALYTIC GEOMETRY (3 each) Introduction of homogeneous coordinates and their use in the study of projective properties. Prerequisite: Math. 43.
- 515. PARTIAL DIFFERENTIAL EQUATIONS OF MATHEMATICAL PHYSICS (3) Methods of solution of selected elliptic, parabolic, and hyperbolic partial differential equations, with reference to physical application. Prerequisite: Math. 421.
- 516-517. THEORY OF PROBABILITY (3 each) Sample spaces, combinatorial analysis, limit theorems, random walk, Markov chains, stochastic processes. Prerequisite: Math. 420.



- 520-521. **PROJECTIVE GEOMETRY** (3 each) General study of the subject from the postulational standpoint. Prerequisite: Math. 43. Alternate years or as required.
- 522-523. **METRIC DIFFERENTIAL GEOMETRY** (3 each) The usual classical treatment of the subject. Prerequisite: Math. 43.
- 530-531. **TOPOLOGY** (3 each) Topological spaces, combinatorial topology, applications to algebra and analysis.
532. **THEORY OF SETS** (3) Formal development of set theory on a logical basis and related methodological problems; applications to the foundations of mathematics. Prerequisite: Math. (Phil.) 428.
534. **THEORY OF ALGEBRAIC NUMBERS** (3) Introduction to the number theory of quadratic fields, with study of the theory of ideals in quadratic and higher fields, with application. Prerequisites: Math. 404, 480.
535. **MODERN ALGEBRA** (3) First graduate course in abstract algebra including the basic theory of semigroups, rings, fields, operator groups, and factorization. Prerequisites: Math. 480, 441; or Math. 481.
537. **THEORY OF FIELDS** (3) Selected topics from field theory including extensions and structure of fields; Galois theory; algebraically closed, ordered, and algebraic number fields. Prerequisite: Math. 535.
538. **THEORY OF RINGS** (3) Selected topics from commutative and noncommutative ring theory including ideals, the Jacobson structure theory, and special classes of rings. Prerequisite: Math. 535.
539. **LATTICE THEORY** (3) Selected topics from lattice theory including complete, modular, complemented, and distributive lattices and applications. Prerequisite: Math. 535.
- 542-543. **THEORY OF STATISTICS** (3 each) Univariate and multivariate distributions, sampling distributions, theory of estimation, statistical hypotheses. Prerequisites: Math. 409, 421.
- 550-551. (Phil. 550-551) **FOUNDATIONS OF MATHEMATICAL LOGIC** (3 each) The nature of logical basis of mathematics; critical examination and development of the basic parts of logical calculus. Prerequisite: Math. 480 or Math. (Phil.) 428.
- 552-553. **NUMERICAL ANALYSIS** (3 each) Topics from: interpolation and integration with remainder terms; approximation theory; asymptotic expansion; solutions of algebraic, differential, integral equations. Prerequisites: Math. 421, 453.
554. (Phil. 554) **METAMATHEMATICS** (3) Prooftheoretic and modeltheoretic study of systems: Gödel's theorem, relative and absolute consistency proofs, decidability, properties of relational structures, mathematical applications. Prerequisite: Math. (Phil.) 428.
555. **SELECTED TOPICS IN MATHEMATICS FOR CHEMISTS** (3) An introduction to matrices, groups, group representations, characters, and orthogonal functions.
556. (Phil. 556) **RECURSION THEORY** (3) Recursive functions; recursive and recursively enumerable sets; equivalent formulations of computability; Church's thesis; related topics from current literature. Prerequisite: Math. (Phil.) 428.
- 560-561. **THEORY OF DIFFERENTIAL EQUATIONS** (3 each) Prerequisites: Math. 44, 421.
565. **FUNCTIONAL ANALYSIS** (3) Theory of Banach and Hilbert spaces, including functionals and operators, and related topics. Prerequisite: Math. 420.

## MATHEMATICS

- 570. SPECIAL TOPICS IN GEOMETRY (3-6)
- 571. SPECIAL TOPICS IN ANALYSIS (3-6)
- 572. SPECIAL TOPICS IN ALGEBRA (3-6)
- 573. SPECIAL TOPICS IN APPLIED MATHEMATICS (3-6)
- 574. SPECIAL TOPICS IN FOUNDATIONS OF MATHEMATICS (3-6)
- 575-576. MATHEMATICS SEMINAR (1-6 each) Selected topics from recent mathematical developments.

## MECHANICAL ENGINEERING

RICHARD G. CUNNINGHAM, *Head of the Department*  
207 Mechanical Engineering Building

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Professors Ambrosius, Cunningham, DiIlio, Hussmann, Meyer, and Olson; Associate Professors Brickman, DeCarolus, Jenks, and Lester; Assistant Professor Schmidt.

Graduate programs in mechanical engineering emphasize thermal engineering or design engineering. Courses and facilities permit studies in thermodynamics, fluid mechanics, heat transfer, advanced design engineering, internal combustion engines, machine dynamics, gas turbines, lubrication, automatic control systems, and power generation and utilization.

To be admitted, a student should be a graduate of an accredited curriculum in mechanical engineering. Graduates of other accredited engineering or physical science curriculums may be admitted, but will be required to make up undergraduate deficiencies without graduate credit.

### MECHANICAL ENGINEERING (M E)

- 401a,b,c,d. MECHANICAL ENGINEERING (3-12)
- 402. AIR CONDITIONING (3)
- 403. ROCKET PROPULSION (3)
- 409. GAS TURBINES (3)
- 410. POWER PLANTS (3)
- 411. REFRIGERATION (3)
- 412. HEAT TRANSFER (3)
- 413. INTERNAL COMBUSTION ENGINES (3)
- 417. THEORY OF ENGINEERING INSTRUMENTS (3)
- 418. PRINCIPLES OF TURBOMACHINERY (3)
- 450. DESIGN OF MACHINE TOOLS (3)
- 451. ADVANCED MACHINE DESIGN PROBLEMS (3)
- 452. MACHINE DESIGN ANALYSIS (3)
- 453. BEARING DESIGN AND LUBRICATION (3)
- 455. AUTOMATIC CONTROL SYSTEMS (3)
- 457. ADVANCED MECHANISMS (3)
- 502. ADVANCED GAS TURBINES (3-6) Analytical study of gas turbine compressors and turbines; combustion; complex cycles; recent developments. Prerequisite: M.E. 409.

## MECHANICAL ENGINEERING

504. **ADVANCED ENGINEERING THERMODYNAMICS (3-6)** Pure and applied thermodynamics including its application to advanced engineering problems; collateral reading and discussion of the classical works on the subject. Prerequisite: M.E. 42.
505. **HEAT TRANSMISSION (3-6)** Applications of principles of heat transfer to efficient design of mechanical engineering equipment. Prerequisite: M.E. 412.
506. **SELECTED TOPICS IN MECHANICAL ENGINEERING (1-12)** Advanced courses adapted to the individual requirements of graduates in mechanical engineering.
518. **TURBOMACHINERY (3)** Similarity considerations and basic equations of turbomachinery; limiting flow conditions; theory and design of vane systems; special topics.
519. **COMPRESSIBLE FLUID FLOW (2-4)** Two-dimensional subsonic flow; similarity rules; theory of characteristics; two-dimensional supersonic flow; oblique shock waves.
520. **NONSTEADY FLOW OF COMPRESSIBLE FLUIDS (2-4)** Method of characteristics; general flow problems; boundaries and discontinuities; interaction of discontinuities; wave diagram techniques and applications.
550. **ANALYSIS OF DESIGN PROBLEMS (3)** Case problems in machine design requiring integrated application of engineering knowledge.
552. **ADVANCED DYNAMICS OF MACHINES (3-6)** Linear and torsional vibrations in and balancing of rotating and reciprocating machinery; exact analysis of stresses produced by these and other dynamic forces in machine parts. Prerequisites: E.Mch. 12, M.E. 54.
553. **FRICTION AND LUBRICATION (3)** The hydrodynamic theory of lubrication and methods of applying it to bearing design, together with a survey of methods of testing lubricants.
555. **AUTOMATIC CONTROL SYSTEMS (3)** Advanced problems and techniques in the design of automatic control systems with emphasis on stability, controller design, and optimum performance. Prerequisite: M.E. 455.
557. **MECHANISM SYNTHESIS (3)** Design and analysis of mechanisms for specific motion and energy requirements; intermittent mechanisms. Prerequisite: M.E. 457.
580. **INVESTIGATION PROJECTS (2-6)** Special experimental studies or investigations in mechanical engineering, adapted to individual requirements.

## METALLURGY

ROBERT W. LINDSAY, *Head of the Department*  
5 Mineral Sciences Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Lindsay, Muan, and Read; Assistant Professors Hoke and Ryba.

There is opportunity for a student to specialize, both in research and in course work, in chemical metallurgy, physical metallurgy, mechanical metallurgy, or the science of metals. Minor work in any of these specializations is available for students majoring in another field.



## METALLURGY

The requirements for admission are a satisfactory bachelor's degree in metallurgy, metallurgical engineering, chemistry, chemical engineering, physics, mechanical engineering, or engineering mechanics; or a satisfactory bachelor's degree in another field, provided it has included the equivalents of mathematics through ordinary differential equations; 8 credits of physics; 12 of chemistry; 10 of other scientific, engineering, or mineral science fields; and 10 of metallurgy. Students who lack some of these requirements may be admitted but are required to take the prerequisite courses without being able to apply them toward an advanced degree.

### METALLURGY (METAL)

- 405. FERROUS METALLOGRAPHY (3)
- 406. NONFERROUS METALLOGRAPHY (3)
- 407. METALLURGICAL ENGINEERING I (2)
- 408. METALLURGICAL ENGINEERING II (3)
- 409. METALLURGICAL INVESTIGATIONS I (2)
- 410. METALLURGICAL INVESTIGATIONS II (2)
- 412. SOLID STATE METALLURGY (3)
  
- 501. METALLURGICAL PROBLEMS (1-6 per term) Independent study of special problems in metallurgy.
- 502. SEMINAR IN METALLURGY (1-6) Conferences, reading, reports, and special lectures.
  
- 511. ADVANCED PHYSICAL METALLURGY (3) Physical metallurgy of an advanced nature; consideration of solid state bonding, crystal structure, alloy constitution, atom movements. Prerequisites: Chem. 452, Metal. 303, 412. *Mr. Ryba*
- 513. ADVANCED CHEMICAL METALLURGY (3) Application of thermodynamics and kinetics to the heterogeneous metallurgical processes of oxidation, reduction, smelting, and refining. Prerequisites: Chem. 452, Metal. 301, 302, 304.
- 515. CORROSION OF METALS (3) Phenomena and theories of metallic corrosion; principles of alloy selection for engineering and structural uses in corrosive environments. Prerequisites: Metal. 511, 513. *Mr. Read*
- 516. FLOW AND FRACTURE OF SOLIDS (3) Phenomenological and theoretical treatment of flow and fracture in solids. Prerequisites: Metal. 511, 513. *Mr. Hoke*
- 518. CONSTITUTION OF METALLURGICAL SYSTEMS (3) Application of thermodynamic principles to study of heterogeneous equilibrium in alloy, slag, and slag-metal systems. Prerequisites: Metal. 511, 513.
- 519. ADVANCED FERROUS METALLURGY (3) Physicochemical principles applied to reactions in iron- and steelmaking systems, including gas, metal, slag, and refractory phases. Prerequisite: Chem. 452 or Metal. 513. *Mr. Muan*
- 520. FOUNDRY METALLURGY (3) Physical-chemical considerations of the liquid state, solidification, and the solid state as applied to casting of metals and alloys. Prerequisites: Metal. 511, 513. *Mr. Lindsay*
- 522. SOLID-PHASE REACTIONS IN METALS (3) Mechanisms and rate determining factors in solid-phase reactions in metals; diffusion processes, nucleation theory, precipitations from solid solution, eutectoid decomposition and order-disorder phenomena. Prerequisites: Metal. 511, 513. *Mr. Ryba*
- 524. ADVANCED METAL WORKING (3) Elements of mathematical theory of plasticity; metal working processes; measurement of deformations in metal working; theory of metal working. Prerequisite: Metal. 516. *Mr. Hoke*

525. METAL FINISHING (3) Metallic coatings and their metallurgical properties; theories and problems of application, utilization, and evaluation. Prerequisite: Metal. 515. Mr. Read

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in metallurgical studies are listed under Mineral Sciences.

## METEOROLOGY

CHARLES L. HOSLER, JR., *Head of the Department*  
322 Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Blackadar, Hosler, Neuberger, and Panofsky; Associate Professor Stephens; Assistant Professor Duquet.

Candidates in meteorology may specialize in aerosol and cloud physics, various phases of dynamic meteorology including turbulence and atmospheric circulation, atmospheric optics and electricity, macro- and microclimatology, agricultural meteorology, synoptic meteorology, or meteorological instrumentation.

Requirements for admission include mathematics through differential equations, one year of college physics, and 12 credits in meteorology. Students with a strong background in mathematics, physics, or engineering may be admitted with deficiencies but must make up such deficiencies before they are admitted to candidacy for a degree.

### METEOROLOGY (METEO)

- 400. METEOROLOGY FOR TEACHERS (3)
- 411. INTRODUCTION TO SYNOPTIC METEOROLOGY (3)
- 412. SYNOPTIC METEOROLOGY (3)
- 418. INTRODUCTORY PHYSICS OF THE UPPER ATMOSPHERE (3)
- 420. TROPICAL METEOROLOGY (3)
- 430. INTRODUCTION TO SYNOPTIC METEOROLOGY LABORATORY (3)
- 431. SYNOPTIC METEOROLOGY LABORATORY I (3)
- 432. SYNOPTIC METEOROLOGY LABORATORY II (2-10)
- 433. ADVANCED SYNOPTIC ANALYTICAL TECHNIQUES (3)
- 443. PHYSICAL METEOROLOGY (3)
- 445. HYDROMETEOROLOGY (3)
- 450. APPLICATIONS OF STATISTICS TO METEOROLOGY (3)
- 451. THERMODYNAMICS OF THE ATMOSPHERE (3)
- 452. HYDRODYNAMICS OF THE ATMOSPHERE (3)
- 461. THEORY OF METEOROLOGICAL INSTRUMENTS (3)
- 472. PHYSICAL AND DYNAMIC CLIMATOLOGY (3)
- 492. METEOROLOGICAL SEMINAR (1-2)
  
- 500. METEOROLOGICAL SEMINAR (1-3) Discussion of meteorological reports and papers; scientific outlook. Prerequisites: Meteo. 411, 451.
- 502. SELECTED TOPICS OF ADVANCED METEOROLOGY (2) Current problems in meteorology. Prerequisite: a minimum of 15 credits in meteorology.
- 503. ATMOSPHERIC TURBULENCE (3) Atmospheric diffusion, heat conduction, friction, and evaporation; statistical properties of turbulence.

## METEOROLOGY

505. BIOCLIMATOLOGY (2) Climatic phenomena in their relation to life. Prerequisite: Meteo. 472.
506. ADVANCED METEOROLOGICAL ANALYSIS (2-6) Physical analysis of atmospheric phenomena; synoptic analysis of weather phenomena for advanced students. Prerequisite: Meteo. 412.
507. DYNAMIC OCEANOGRAPHY (2) Physical properties of sea water; heat balance of the oceans; theory and observations of ocean currents, waves, and tides.
508. PHYSICS OF THE UPPER ATMOSPHERE (2) Temperature distribution, composition, and electrical characteristics of the upper atmosphere; theories of aurora and light of the night sky.
509. THEORETICAL CLIMATOLOGY (2) Theory of latitudinal, annual, and diurnal temperature changes; theories of climatic changes; microclimate.
510. CLOUD PHYSICS (2) Current theories on phase changes in clouds and mechanisms responsible for precipitation; techniques of cloud modification and control.
551. ATMOSPHERIC WAVE MOTION (2) From classical and physical hydrodynamics to the numerical prediction of wave motion in a baroclinic atmosphere. Prerequisite: Meteo. 452.
552. ADVANCED ATMOSPHERIC DYNAMICS (2) Numerical prediction models, general circulation, thermal and gravitational tides in a spherical shell, and empirical orthogonal functions of statistical forecasting. Prerequisite: Meteo. 551.

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in meteorological studies are listed under Mineral Sciences.*

## MINERAL ECONOMICS

JOHN D. RIDGE, *Head of the Department*  
207 Mineral Sciences Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Ridge and Schanz; Associate Professor McDivitt.

A student may specialize in the economics of exploration for, and the extraction, beneficiation, and utilization of, the ferrous and nonferrous metals, the nonmetallics, the fuels, and ground water. Work is also offered in property evaluation, analysis of mineral data, and the influence of technological advances on mineral economics.

The requirements for admission are 24 credits in chemistry, physics, and mathematics; 12 in geology, mineralogy, and/or the biological sciences; 9 in mineral economics, economics, commerce, and/or geography; and 6 in mining, metallurgy, petroleum engineering, ceramics, and/or industrial engineering.

Students having a deficiency of 9 credits or fewer in this total of 51 may be admitted as regular graduate students but will be required to make up such deficiencies without the credits being applicable toward the advanced degree.

### MINERAL ECONOMICS (MN EC)

400. SEMINAR (1)  
453. NONMETALLIC MINERALS (3)  
483. THE METALS AND THEIR ORES (3)



## MINERAL ECONOMICS

484. THE SOLID FUELS (3)  
486. PETROLEUM AND NATURAL GAS ECONOMICS (3)  
490. MINERAL VALUATION (3)  
491. ANALYSIS OF MINERAL DATA (2)
500. ADVANCED PRINCIPLES OF MINERAL ECONOMICS (3-6) Economic history of mineral industries, research methods, economics of mineral exploitation and utilization, mineral policy.
501. RESEARCH IN MINERAL ECONOMICS (3-6) Investigation in specialized fields of research in mineral economics. Prerequisite: 3 credits in Mn.Ec. 500.
502. TECHNOLOGIC INFLUENCES (3-9) Relationship of technologic advancements to economic development of the mineral industries. Prerequisite: 3 credits in Mn.Ec. 500.
505. PROBLEMS OF MINERAL ECONOMICS (3-12) Determination of basic technologic-economic patterns of selected mineral industries. Prerequisite: 3 credits in Mn.Ec. 500.

## MINERAL PREPARATION

H. BEECHER CHARMBURY, *Head of the Department*  
4 Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Charmbury, Spicer, and Sun; Associate Professor Lovell.

Areas in which students may specialize include the fundamentals of gravity, electrical, and chemical methods of beneficiating natural mineral deposits. Graduate work may also be undertaken on the properties of specific minerals as they are related to beneficiation.

Graduates with a bachelor's degree in such scientific fields as chemistry, physics, and mathematics, and in such engineering fields as mining, metallurgy, ceramics, fuel technology, and mechanical, electrical, and civil engineering are eligible for admission. However, graduates in the above fields are required to take 6 credits of undergraduate courses in mineral preparation along with their graduate program.

### MINERAL PREPARATION (MN PR)

401. ADVANCED MINERAL PREPARATION LABORATORY (1)  
404. PLANT LAYOUT AND DESIGN (3)  
410. COAL PREPARATION (3)  
420. UNIT OPERATIONS (3)  
430. FLOWSHEETS OF MINERAL PREPARATION PLANTS (3)  
457. FIELD TRIP (1-2)
502. FROTH FLOTATION AND AGGLOMERATION (3) Intensive study of theory and applications of froth flotation and agglomeration. Prerequisite: Mn.Pr. 420.  
*Mr. Sun*
504. MINERAL PREPARATION RESEARCH (1-6 per term) Research work on specific problems in mineral preparation. Prerequisite: Mn.Pr. 410 or 420.  
*Mr. Charmbury and Staff*

## MINERAL PREPARATION

505. GRAVITY PROCESSES AND MISCELLANEOUS METHODS OF MINERAL PREPARATION (3) Intensive study of theory and applications of gravity, magnetic, electrostatic, centrifugal, and dense-media processes of mineral concentration. Prerequisite: Mn.Pr. 420. *Mr. Spicer*
506. MINERAL PREPARATION PLANT DESIGN (3-10) Layout, design, and selection of equipment for specific mineral preparation plant projects. Prerequisite: Mn.Pr. 420. *Mr. Spicer*
507. CHEMICAL PROCESSES OF MINERAL PREPARATION (3) Practice and theory of methods to upgrade ores by chemical treatment including roasting, solubility separations, surface phenomena, and reactions. Prerequisite: Mn.Pr. 420. *Mr. Lovell*

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in mineral preparation studies are listed under Mineral Sciences.

## MINERALOGY AND PETROLOGY

JOHN C. GRIFFITHS, *Head of the Department of Mineralogy*  
114 Mineral Sciences Building

*Degrees Conferred: Ph.D., M.S.*

*Graduate Faculty:* Professors Bates, Griffiths, Krynine, and Vand; Associate Professors Wright and Wyllie.

Areas of specialization include igneous, sedimentary, and metamorphic petrology, mineralogy, crystal chemistry, X-ray mineralogy, clay mineralogy, ore mineralogy, and applications of statistics in the earth sciences.

The general requirements for admission are mathematics through integral calculus, chemistry through quantitative analysis, 10 credits of general physics, 30 credits of geology, petrology, and mineralogy including microscopical petrography (i.e., an equivalent to G.Sc. 485, acceptable to the faculty).

Additional specific requirements must be fulfilled in most areas of specialization. Deficiencies may, in most cases, be made up after admission.

### GEOLOGICAL SCIENCES (G SC)

- |                             |                      |
|-----------------------------|----------------------|
| 463. OPTICAL MINERALOGY (2) | <i>Mr. Wright</i>    |
| 464. OPTICAL MINERALOGY (1) | <i>Mr. Wright</i>    |
| 483. PETROLOGY (2)          | <i>Mr. Wyllie</i>    |
| 484. PETROLOGY (2)          | <i>Mr. Griffiths</i> |
| 485. PETROLOGY (2)          | <i>Mr. Wyllie</i>    |

### MINERALOGY (MIN)

500. OPTICAL CRYSTALLOGRAPHY OF MINERALS (3) Optical methods, microscopic techniques, and measurement of optical constants of crystals; theory and application of the universal stage. Prerequisite: G.Sc. 464. *Mr. Wright*
501. PETROLOGY (3-6) Microscopic study of rocks, emphasizing classification and genetic relationships. *Messrs. Krynine, Tuttle, Wyllie, and Griffiths*
502. MINERALOGICAL PROBLEMS (3) Original study of some limited mineralogical or petrological problems.

## MINERALOGY AND PETROLOGY

504. THEORETICAL MINERALOGY (3) Crystal chemistry and crystal physics applied to solid solution, polymorphism, crystal growth, and related phenomena. *Mr. Bates*
505. MINERALOGY SEMINAR (1-2) Reading, presentation, and discussion of literature dealing with various phases of theoretical mineralogy. Topics are selected to meet the interests of the majority of the students.  
*Messrs. Krynine, Tuttle, Bates, Griffiths, Wright, Wyllie, Vand, and Brindley*
- \*510. METAMORPHIC PETROLOGY (2-6) Detailed review of chemical, mineralogical, and structural changes that take place during metamorphism. Prerequisites: G.Sc. 483, 484, 485.
511. SEDIMENTARY PETROLOGY (3-4) Composition, texture, structure, mass properties of sediments; dynamic processes in complex natural systems; sedimentary stages: weathering, erosion, transport, deposition, lithification. Prerequisites: G.Sc. 483, 484, 485. Concurrent: Min. 513. *Mr. Krynine*
512. SEDIMENTARY PETROLOGY, CONTINUED (2-4) Diastrophism and tectonic background of sedimentation; depositional loci; classification of sediments: quartzites, graywackes, arkoses; chemical sediments; paleogeography, paleoclimatology, oil finding. Prerequisite: Min. 511. Concurrent: Min. 514. *Mr. Krynine*
513. METHODS OF ANALYSIS OF SEDIMENTS (3) Principles and practices used in analyzing sedimentary rocks for size, shape, and accessory (heavy) minerals. Concurrent: Min. 511. *Mr. Griffiths*
514. APPLIED SEDIMENTOLOGY (3) Design and control in analysis of sedimentary rocks; application of these techniques to industrial problems. Concurrent: Min. 512. *Mr. Griffiths*
- †517. SEDIMENTS OF THE WORLD (1-9) Microscopic and field studies of representative American and foreign rock suites; correlation with paleogeographic, geotectonic, economic data. Prerequisites: Min. 512, 514. *Mr. Krynine*
520. STUDY OF ACCESSORY MINERALS (2-4) Detailed study of accessory (heavy) minerals; their significance in problems of provenance, petrogenesis, mineral stratigraphy, and paleogeography. Prerequisites: Min. 511, 512, 513, 514. *Mr. Griffiths*
524. INTRODUCTION TO SEDIMENTATION (3) Prerequisites: G.Sc. 483, 484. Concurrent: G.Sc. 485. *Mr. Krynine*
525. IGNEOUS PETROLOGY (2-6) Origin, distribution, and composition of igneous rocks. Prerequisites: G.G. 513; G.Sc. 483, 484, 485; Min. 500, 527. *Mr. Tuttle*
526. STATISTICAL PROBLEMS IN SEDIMENTARY GEOLOGY (3) Application of experimental design, sampling procedures, multiple regression and discriminant analysis in solving problems in sedimentary petrography. Prerequisites: Min. 514; Math. 410 or Agro. 545. *Mr. Griffiths*
527. IGNEOUS AND METAMORPHIC MINERALOGY (3) Structural and compositional variations of minerals in igneous and metamorphic rocks.
529. RADIOACTIVITY IN ROCKS (1-2) Distribution, mineralogy, and petrology of the radioactive elements. *Mr. Wright*
530. (Cer.T. 530) STRUCTURE, PROPERTIES, AND OCCURRENCE OF CLAY MINERALS

\*Credits to be arranged, 2-4 per term.

†Credits to be arranged, 1-3 per term.



## MINERALOGY AND PETROLOGY

(2-5) Structure analysis and identification of clay minerals; mineral transformations and behavior; occurrence, genesis, and petrography of fine-grained sediments.

*Messrs. Griffiths, Bates, and Brindley*

*NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in mineralogical studies are listed under Mineral Sciences.*

## MINING ENGINEERING

HOWARD L. HARTMAN, *Head of the Department of Mining*  
305B Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Hartman, Kochanowsky, and Mitchell; Assistant Professor Stefanko.

Areas of specialization which may be followed in research and course work include mine property valuation and economics of mining engineering (ore estimation, cost analysis and control, budgeting), mechanization and mine plant (unit operations, materials handling, continuous mining, power supply), development and exploitation methods (mine planning and layout, design of systems), mine management, production engineering and operations research (time study, standards, job rating, operations analysis), environmental control (gas and dust technology, ventilation, air conditioning, hygiene, illumination, safety), and rock mechanics (stress analysis, roof and ground control, penetration, fragmentation).

A bachelor's degree in mining engineering or some related engineering field is required for admission to graduate work. Students may be required to make up deficiencies in their area of specialization. Certain basic, related courses outside the department may be approved as part of the major.

### MINING (MNG)

- 401. MINE MATERIALS HANDLING (3)
- 402. MINE POWER (3)
- 410. MINING ENGINEERING ANALYSIS (2)
- 411. MINE PRODUCTION ENGINEERING (2)
- 412. MINE MANAGEMENT (2)
- 422. MINE VENTILATION AND AIR CONDITIONING (3)
- 431. ROCK MECHANICS (3)
- 451-452. ADVANCED MINING ENGINEERING I and II (1 each)
- 490. SENIOR MINING SEMINAR (1)
  
- 513. MINE COST ANALYSIS (3) Nature of mining costs, their analysis and control: depreciation and depletion, capital and operating costs, budgets, records.
- 514. MINE OPERATIONS ANALYSIS (3) Scientific planning and layout of mining operations based on time studies, mathematical analysis, and proportionality of centroids of reserves. Prerequisites: Math. 100 or 45, Mng. 411.
- 525. DUST TECHNOLOGY (3) Physical and chemical properties of dusts; airborne dust determinations and analysis; dust control applicable to mills and mines. Prerequisite: Mng. 422.
- 526. MINE VENTILATION (3) Airflow in mine openings and its control; network solution by mathematics and computer; design of mine and industrial ventilation systems. Prerequisite: Mng. 422.

## MINING ENGINEERING

528. MINE AIR CONDITIONING (3) Thermodynamics of vapor mixtures; heat flow through rock; physiological effects of hot, humid environments; design of temperature-humidity control systems. Prerequisite: Mng. 422.
532. ROCK MECHANICS (3) Behavior of rock under static loading; underground stress instrumentation; experimental stress analysis; design of mine openings; theories of subsidence. Prerequisite: Mng. 431.
541. THEORY OF ROCK PENETRATION (3) Behavior of rock under dynamic loads intended to penetrate; basic energy relations; application of theory to drilling and other penetration. Prerequisites: E.Mch. 13, Mng. 30, Phys. 203.
542. THEORY OF ROCK FRAGMENTATION (3) Behavior of rock under dynamic loads intended to fragment; physical chemistry of explosives; detonation; theory of blasting; design of drill rounds. Prerequisites: E.Mch. 13, Mng. 30, Phys. 203.
580. MINING ENGINEERING RESEARCH (1-3 per term) Supervised research on a specific problem involved in mining science or technology.
590. GRADUATE MINING SEMINAR (1 per term) Preparation and presentation of formal papers on problems of an advanced nature in mining engineering. Required once during each year of residence.

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in mining studies are listed under Mineral Sciences.

## MUSIC

HUMMEL FISHBURN, *Head of the Department*  
Armory

*Degree Conferred:* M.A.

*Graduate Faculty:* Professors Fishburn, Henninger, and Taylor; Associate Professors Ceiga and Karhan; Assistant Professor Brinsmaid.

In his graduate program a student may emphasize one of the following areas, or may elect a program including work in all of them: theory, performance, music literature, and creative music. The minor must be chosen from the liberal arts. Admission to this graduate program requires completion of a recognized music curriculum.

### MUSIC (MUSIC)

407. PIANO LITERATURE (3)  
408. VOCAL LITERATURE (3)  
410. MUSIC OF THE 20TH CENTURY (3)  
411. LITERATURE OF THE VIOLIN (3)  
412. MUSIC OF THE BAROQUE PERIOD (3)  
\*429. SINGER'S STYLE AND INTERPRETATION (3) Fee \$50.  
456. ELEMENTARY COUNTERPOINT (3)  
459. MODERN INSTRUMENTAL ARRANGING (3)  
466. ADVANCED CONDUCTING (3)
- \*503. ADVANCED STRINGED INSTRUMENTS (3) Study, repertoire building, and recital performance. Fee \$50.

\*May be repeated for a total of 12 credits.

## MUSIC

- \*511. ADVANCED PIANO (3) Piano literature of all periods for public performance. Fee \$50.
- \*531. ADVANCED ORGAN (3) Study, repertoire building, and recital performance. Prerequisite: 4 credits of Music 31 and/or 38. Fee \$60.
543. MODERN HARMONY (3) Harmonic writing based on 20th century practices with attention to traditional idioms that serve as foundation.
557. SYMPHONIC STRUCTURE (3) Survey of the evolution and application of the forms used in symphony, sonata, concerto, string quartet, and related works. Prerequisite: Music 57.
- \*558. FREE COMPOSITION (3) Composition: vocal and instrumental, standard or modern idioms. Prerequisite: 18 credits in harmony, counterpoint, and piano.
563. FREE ARRANGING (3) Correct procedure in arranging for vocal and instrumental ensembles; practical exercises in quartets, glee clubs, and choruses; small instrumental groups, band, and orchestra. Prerequisite: 18 credits in harmony, including 3 of orchestration.
567. THE LITERATURE OF THE ORCHESTRA (3) The suite, symphony, tone poem, and overture from the point of view of appreciation, form, and orchestration. Prerequisites: Music 6 and theoretical knowledge of the key instruments of the orchestra.
599. MUSIC SEMINAR (1-3) Seminar in the history, art, and science of music, with readings, discussion, and performance.

## MUSIC EDUCATION

HUMMEL FISHBURN, *Head of the Department*  
264 Chambers Building

*Degrees Conferred:* D.Ed., M.Ed.

*Graduate Faculty:* Professors Andrews, Dunlop, and Fishburn; Associate Professors Campbell and Karhan.

A student majoring in music education is required to offer a minor in music. However, the master's program must include some work, and the doctoral program considerable work, in the area of general education.

Doctoral students may specialize in vocal, instrumental, or theoretical music in elementary, secondary, or college teaching; but the degree requires work in each of these fields.

For admission to a graduate program a student must have completed a recognized music education curriculum.

### MUSIC EDUCATION (MU ED)

446. THE ELEMENTARY MUSIC SPECIALIST (3)
462. PEDAGOGY OF THEORY (3)
468. THE TEACHING OF PIANO (3)
469. BAND AND ORCHESTRA TECHNIQUE (3)
470. CHORAL TECHNIQUE (3)
475. OBJECTIVES AND PROBLEMS IN ELEMENTARY MUSIC EDUCATION (3)
480. CHORAL PROGRAM IN THE SECONDARY SCHOOL (3)

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\*May be repeated for a total of 12 credits.



## MUSIC EDUCATION

500. MUSIC EDUCATION SEMINAR (3-6) Problems of various phases of music education, both instrumental and vocal; research and literature dealing with these problems.
569. PRESENT-DAY TRENDS IN INSTRUMENTAL MUSIC (3) New methods and materials for band, orchestra, and ensembles.
572. INSTRUMENTAL PEDAGOGY (3-6) Research problems in band and orchestra. Prerequisite: Mu.Ed. 54 or practical experience.
573. THE MATERIALS OF APPRECIATION (3) Methods and materials for development of music appreciation in elementary and secondary schools. Prerequisites: Music 5, teaching experience.
574. PRESENT-DAY TRENDS IN MUSIC EDUCATION (3-6) Present-day music education materials and methods (elementary and secondary levels) in relation to modern educational philosophy; emphasis upon practical problems presented by members of the class. Prerequisites: Mu.Ed. 48, teaching experience.
575. THE JUNIOR HIGH SCHOOL MUSIC CURRICULUM (3) Instructional materials, procedures, curricular and extracurricular activities, integration with other subjects.
576. MUSIC SUPERVISION (3) Current educational procedures in training music supervisors.
581. CONTEMPORARY MUSIC EDUCATION (3) Prerequisite: 20 credits at the graduate level including Mu.Ed. 500.
594. PEDAGOGY OF EAR TRAINING (3) Materials and methods for training the listener to grasp, understand, and write what is heard from melody to four-part harmony. Prerequisite: 12 credits in ear training and/or harmony.

## NUCLEAR ENGINEERING

NUNZIO J. PALLADINO, *Head of the Department*  
231 Sackett Building

*Degrees Conferred:* M.S., M.Eng.

*Graduate Faculty:* Professor Palladino; Associate Professors Diethorn, Foderaro, and Kline.

A student may specialize in reactor analysis, reactor heat transfer, reactor structures, nuclear materials, or reactor instrumentation and control. Admission requires a bachelor's degree in engineering or in the physical sciences. Students who have not had appropriate undergraduate courses in modern physics and differential equations will be required to schedule them.

### NUCLEAR ENGINEERING (NUC E)

410. NUCLEAR ENGINEERING (3)
411. NUCLEAR ENGINEERING (3)
420. RADIOLOGICAL SAFETY (2)
501. REACTOR ENGINEERING (3) Reactor controls, shielding of nuclear reactors, stress analysis of reactor materials, power cycle analysis, breeding, and advanced design considerations. Prerequisite or concurrent: Nuc.E. 520.

## NUCLEAR ENGINEERING

502. REACTOR ENGINEERING LABORATORY (1-5) Reactor experiments devised to acquaint the student with reactor technology. Prerequisite or concurrent: Nuc.E. 520.
503. THERMONUCLEAR ENGINEERING (3) Binary fusion reactions; microscopic and macroscopic phenomena in a completely ionized gas; electromagnetic confinement; design, operation, and diagnostics of experiments. Prerequisite: Math. 452.
505. REACTOR INSTRUMENTATION AND CONTROL (3) Neutron-detecting instruments and circuits; in-core power instrumentation; reactor control principles; control mechanisms; operational control problems. Prerequisite: Nuc.E. 411.
507. INTERACTION OF RADIATIONS WITH MATTER (2) Theory of the processes by which gamma rays, neutrons, and charged particles interact with electrons, atoms, and nuclei. Prerequisites: Phys. 406; 454 or 456.
508. RADIATION SHIELDING (2) Radiation sources in reactor systems; attenuation of gamma rays and neutrons; deep penetration theories; Monte Carlo methods. Prerequisite: Nuc.E. 507.
509. RADIATION DAMAGE IN SOLIDS (2) Production of defects by high energy particles; nature of defects; diffusion and annealing in solids; macro property changes. Prerequisite: Nuc.E. 507.
520. REACTOR ANALYSIS (3) Physical principles and mathematical methods of reactor analysis. Prerequisite: Nuc.E. 410.
521. NEUTRON TRANSPORT THEORY (3) Derivation of Boltzmann equation for neutron transport; techniques of approximate and exact solution for the monoenergetic and spectrum regenerating cases. Prerequisite: Nuc.E. 410 or Phys. 406.
550. SPECIAL TOPICS IN NUCLEAR ENGINEERING (1-12) Theoretical studies in nuclear engineering with or without associated experimental work. Prerequisites: Math. 44, Phys. 406.

## PHYSICAL SCIENCE (PH SC)

501. SEMINAR IN NUCLEAR SCIENCE AND ENGINEERING (0)

## PETROLEUM AND NATURAL GAS ENGINEERING

C. DREW STAHL

*Head of the Department of Petroleum and Natural Gas*  
26 Mineral Industries Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Nielsen, Slobod, and Stahl; Associate Professors Bissey and Burcik.

Areas of specialization include experimental and theoretical studies of water flooding and the newer methods for displacing oil from porous media, methods for calculating reservoir performance, scaled laboratory studies of reservoir phenomena, and drilling and well completion problems.

Students who expect to enter graduate study in this field with a degree in another curriculum should present 20 credits of chemistry and physics, 6 of geology, 15 of engineering science, and credit for mathematics through integral calculus. A limited number of deficiencies may be made up after admission.

## PETROLEUM AND NATURAL GAS

Certain closely related courses outside the department may be counted as petroleum and natural gas credits toward the degree.

### PETROLEUM AND NATURAL GAS (P N G)

- 410. APPLIED RESERVOIR ENGINEERING (3)
- 420. APPLIED RESERVOIR ANALYSIS (3)
- 421. RESERVOIR ENGINEERING (3)
- 431. DRILLING FLUIDS (2)
- 450. DRILLING DESIGN AND PRODUCTION ENGINEERING (4)
- 480. PRODUCTION PROCESS ENGINEERING (3)
- 481. NATURAL GAS AND GASOLINE PLANTS (2)
- 485. ENGINEERING IN SECONDARY RECOVERY (3)
- 490. ADVANCED CORE TESTING (3)
  
- 510. FLOW OF HOMOGENEOUS FLUIDS THROUGH POROUS MEDIA (3) Concepts and mathematics describing steady and unsteady state flow in porous media for various initial and boundary conditions.
- \*512. RESERVOIR ENGINEERING (3-6) Applications of the principles of fluid behavior in porous media to the analysis of complex reservoir behavior; log interpretation. Prerequisite: P.N.G. 510.
- 515. SECONDARY RECOVERY (3) Methods of predicting oil recovery by immiscible fluid injection.
- 517. CASE STUDIES OF SECONDARY RECOVERY (1-3) Interpretation and critical analysis of production and injection characteristics of typical water flood operations. Prerequisite: P.N.G. 515 or 485.
- 520. PHASE RELATIONS IN RESERVOIR ENGINEERING (3) Phase relations as applied to condensate and retrograde condensate reservoirs and to other problems in petroleum production.
- 525. SPECIAL TOPICS IN PETROLEUM ENGINEERING (2-6)
- 530. NATURAL GAS ENGINEERING (1-3) Flow in producing or storage reservoirs; gas well testing; transmission systems; storage cycles; current developments. Prerequisite: P.N.G. 481.
- †535. SEMINAR (1-3)

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in petroleum and natural gas studies are listed under Mineral Sciences.

## PHILOSOPHY

JOHN M. ANDERSON, *Head of the Department*  
211 Sparks Building

*Degrees Conferred:* Ph.D., D.Ed., M.A., M.Ed.

*Graduate Faculty:* Professors Anderson, Bugbee, Finch, Freund, Johnstone, and Mourant; Associate Professor Pape; Assistant Professors Gotshalk, Rosen, and Tsugawa.

\*Credits to be arranged, 3 per term.

†Credits to be arranged, 1 per term.



## PHILOSOPHY

A student may concentrate on history of philosophy, logic and scientific methods, or value theory. Undergraduate preparation should include a major in philosophy, but a strong minor may also be acceptable.

### PHILOSOPHY (PHIL)

- 406. MEDIEVAL PHILOSOPHY (3)
- 410. STUDIES IN GREEK PHILOSOPHY (3-6)
- 411. STUDIES IN MODERN PHILOSOPHY (3-6)
- 413. PHILOSOPHY OF LITERATURE (3)
- 414. AESTHETIC THEORY (3)
- 417. NINETEENTH CENTURY PHILOSOPHY (3)
- 418. RECENT AND CONTEMPORARY PHILOSOPHY (3)
- 419. PHILOSOPHICAL BACKGROUNDS OF AMERICAN THOUGHT (3)
- 426. METAPHYSICS (3)
- 427. ADVANCED ETHICS (3)
- 428. (Math. 428) LOGICAL THEORY (3)
- 429. SEMANTICS: PHILOSOPHY OF LANGUAGE AND SYMBOLISM (3)
- 430. PHILOSOPHICAL PROBLEMS (3-6)
- 435. RELIGION AND SCIENCE (3)
  
- 500. ETHICS: HISTORICAL AND SYSTEMATIC (2-6) Critical study of some phase of ethical theory, or of some period of the history of ethics.
- 504. SOCIAL AND POLITICAL PHILOSOPHY (3) Critical study of basic problems in their historical and functional setting.
- 505. IDEALS OF WESTERN CIVILIZATION (3) Analysis of contemporary ideals in terms of their Graeco-Judean bases.
- 506. SEMINAR IN ANCIENT PHILOSOPHY (3-6) Study of one or more important men or movements in ancient philosophy.
- 507. SEMINAR IN MEDIEVAL PHILOSOPHY (3-6) Study of one or more important men or movements in medieval philosophy.
- 508. SEMINAR IN MODERN PHILOSOPHY (3-6) Men and movements in philosophy from the Renaissance through the 19th century.
- 509. SEMINAR IN CONTEMPORARY PHILOSOPHY (3-6) Men and movements in 20th century philosophy.
- 510. CLASSICS OF SCIENTIFIC METHOD (3-6) Actual reasoning and procedures of historical masters of scientific methods.
- 511. PRINCIPLES OF EXPERIMENTAL INFERENCE (3-6) Science as controlled inquiry; types of scientific procedures in formal, physical, and sociocultural science.
- 512. ADVANCED TOPICS IN PHILOSOPHY OF SCIENCE (3-6) Crucial problems in the theory of science and scientific method.
- 514. SEMINAR IN 19TH CENTURY PHILOSOPHY (3) Study of a philosopher or philosophical movement of the 19th century.
- 515. PHILOSOPHICAL METHOD (3) Methods proposed by classical and contemporary thinkers for reaching philosophical conclusions: deductive, inductive, dialectical, pragmatic, intuitive.
- 516. SEMINAR IN AESTHETICS (3) Problems and theories in the nature of art.

530. PHILOSOPHY RESEARCH SEMINAR (3-6) Study of selected philosophical problems with an emphasis on techniques of philosophical research.
- 550-551. (Math. 550-551) FOUNDATIONS OF MATHEMATICAL LOGIC (3 each) The nature of logical basis of mathematics; critical examination and development of the basic parts of logical calculus. Prerequisite: Math. 480 or Phil. (Math.) 428.
554. (Math. 554) METAMATHEMATICS (3) Prooftheoretic and modeltheoretic study of systems: Gödel's theorem, relative and absolute consistency proofs, decidability, properties of relational structures, mathematical applications. Prerequisite: Phil. (Math.) 428.
556. (Math. 556) RECURSION THEORY (3) Recursive functions; recursive and recursively enumerable sets; equivalent formulations of computability; Church's thesis; related topics from current literature. Prerequisite: Phil. (Math.) 428.

## PHYSICAL EDUCATION

JOHN D. LAWOTHER

*Associate Dean of the College of Physical Education and Athletics*  
246 Recreation Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors Bedenk, Conger, Coombs, Gross, Harnett, Lawther, Speidel, and Thiel; Associate Professors Lucey and Magnusson.

Areas of specialization include: (1) history, philosophy, and principles; (2) applied science (physiology of exercise, kinesiology, body mechanics); (3) organization and administration; (4) objectives, programs, methods, and evaluation; (5) adaptives and correctives; (6) health; and (7) athletics, intramural and interschool. The master's candidate is expected to acquire a basic minimum of knowledge in each of these areas with little specialization except for his thesis or problem. The doctoral candidate is expected to focus on one area during his final year of graduate work.

The requirements for admission to the M.Ed. program are 24 credits in professional health and physical education and 24 in education and psychology, including general psychology, educational psychology, principles and methods of teaching, education electives, and practice teaching.

The requirements for admission to the M.S. program are 36 credits in professional health and physical education and 18 in education and psychology. An excellent background in the biological and physical sciences may satisfy up to half of the requirement in professional health and physical education.

### PHYSICAL EDUCATION (PH ED)

452. ANALYSIS OF PHYSICAL EDUCATION ACTIVITIES FOR THE ELEMENTARY SCHOOL (3)
453. ANALYSIS OF PHYSICAL EDUCATION ACTIVITIES FOR THE HIGH SCHOOL (3)
454. THE NATURAL PROGRAM OF PHYSICAL EDUCATION ACTIVITIES, APPLIED (3)
455. SCIENTIFIC METHOD IN HEALTH AND PHYSICAL EDUCATION (3)
460. METHODS AND PRINCIPLES OF ATHLETIC COACHING (3)
480. ADVANCED ANATOMY AND PHYSIOLOGY, APPLIED (3)
489. INTRAMURAL ATHLETICS (3)
490. INTRODUCTION TO TESTS AND MEASUREMENTS IN HEALTH AND PHYSICAL EDUCATION (3)
491. ORGANIZATION AND ADMINISTRATION OF HEALTH AND PHYSICAL EDUCATION IN SCHOOLS (3)



## PHYSICAL EDUCATION

500. PROBLEM IN PHYSICAL EDUCATION (3) Prerequisite: Ph.Ed. 455.
522. ORGANIZATION AND ADMINISTRATION OF PHYSICAL EDUCATION IN COLLEGES AND UNIVERSITIES (3) Administration of physical education in college; credits, schedules, excuses, records, reports, budgets, classification, tests, staff, and facilities. Prerequisite: Ph.Ed. 491.
523. ADMINISTRATION OF COLLEGE ATHLETICS (3) Eligibility, schedules, managerial systems, relationships of athletics to the physical education program and to education in general. Prerequisite: Ph.Ed. 491.
526. ATHLETIC PROBLEMS IN SCHOOLS (3) Practical problems which result from administration of athletics in schools. Reports on some aspects of athletics required. Prerequisite: Ph.Ed. 460.
528. PROFESSIONAL EDUCATION OF TEACHERS OF HEALTH AND PHYSICAL EDUCATION (3) Health and physical education surveys, publicity, sociability and personality tests, legislation, state certification, standards for facilities and equipment, in-service, follow-up, and teacher-community problems. Prerequisite: Ph.Ed. 491.
529. SUPERVISION OF PHYSICAL EDUCATION IN SCHOOLS (3) Methods and policies of the school supervisor of physical education; conferences, planning and presenting the program, evaluating results, improving teachers-in-service, supervision of the classroom teacher. Prerequisite: Ph.Ed. 491.
530. RESEARCH TECHNIQUES IN HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (3) Prerequisite: Ph.Ed. 490.
531. RESEARCH IN HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (3) Prerequisite: Ph.Ed. 530.
532. TESTS AND MEASUREMENTS IN PHYSICAL EDUCATION (3) Critical study of tests and measurements available in physical education; methods of constructing and evaluating new tests and measurements. Prerequisite: Ph.Ed. 490.
534. STUDIES IN CURRICULUM CONSTRUCTION IN PHYSICAL EDUCATION (3) Principles and methods of curriculum building in physical education; different psychological and educational points of view, organizing a course of study committee, making units of instruction. Prerequisite: Ph.Ed. 454.
535. MODERN FOREIGN SYSTEMS OF PHYSICAL EDUCATION (3) Comparative analysis of national and local programs and systems of physical education in foreign countries. Prerequisites: Ph.Ed. 534, 595.
536. SCIENTIFIC METHODS IN ATHLETIC COACHING (3) Unusual techniques in athletic coaching which are not commonly recognized and used; advanced skills and strategy in coaching major sports. Prerequisite: Ph.Ed. 460.
550. SEMINAR IN HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION (1-6)
555. RELATIONSHIPS OF PHYSICAL EDUCATION TO THE EXACT SCIENCES (3)
560. ADMINISTRATIVE PROBLEMS OF PHYSICAL EDUCATION IN SCHOOLS (3) Solutions to problems emerging from the administration of physical education in schools, fitting physical education into the school's schedule, awards and budgets. Prerequisite: Ph.Ed. 491.
581. PROBLEMS IN BODY MECHANICS (3) Certain aspects of human motion and body segmental alignment; analysis of human gait, and the dynamic adaptation of



## PHYSICAL EDUCATION

the spine, thorax, and pelvis to external physical forces. Prerequisites: Hl.Ed. 244, Ph.Ed. 399.

595. PHILOSOPHY OF HEALTH AND PHYSICAL EDUCATION AND RECREATION EDUCATION  
(3) Prerequisite: Ph.Ed. 491 or Rc.Ed. 465.

## PHYSICAL SCIENCE

HENRY W. KNERR

*Chairman of the Committee on Physical Science*  
101 Willard Building

*Degrees Conferred:* D.Ed., M.Ed.

The M.Ed. program, which is designed to meet the needs of secondary school science teachers, consists of at least 24 credits chosen from chemistry, earth sciences, mathematics, and physics and a minor of at least 6 credits in educational foundations. A candidate is expected to complete at least one course in each of the four sciences and at least 12 credits in chemistry, earth sciences, or physics.

As a minimum requirement for admission a student is expected to have had 10 credits in chemistry, 8 credits in physics, mathematics through trigonometry, and 18 credits in education and related psychology.

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## PHYSICS

JOHN J. GIBBONS, *Acting Head of the Department*  
101 Osmond Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Gibbons, Knerr, Müller, Pepinsky, Pollard, Rank, Roy, Sauer, Schilling, Stoner, Vand, and Webb; Associate Professors Bauer, Burnett, Donahue, Ginoza, Goldberg, Kazes, McCubbin, McKelvey, Myers, Pratt, Schraer, Signell, Strother, Weber, Wiggins, Winter, and Work; Assistant Professors Cutler, McCammon, Person, and Thwaites.

Graduate instruction and research opportunities are available in visible and infrared spectroscopy, crystal structure, solid state, field emission, acoustics, high-pressure physics, biophysics, plasma physics and shock waves, low-temperature physics, nuclear physics, physics of high polymers, and various phases of theoretical physics.

A bachelor's degree in physics or an allied field is required for admission. Students who lack some of the usual upper-class undergraduate courses in physics may be requested to take additional course work without degree credit.

### PHYSICS (PHYS)

- 400. INTERMEDIATE ELECTRICITY AND MAGNETISM (4)
- 402. ELECTRONICS (4)
- 404. ELECTRONIC MEASUREMENTS (2-4)
- 406. NUCLEAR PHYSICS (3)
- 411. THEORETICAL MECHANICS (3)
- 412. INTRODUCTION TO SOLID STATE PHYSICS (3)
- 417. THE TEACHING OF PHYSICS (3)

## PHYSICS

420. INTERMEDIATE HEAT (3)
433. MECHANICS AND FLUID PHYSICS FOR TEACHERS (3)
435. ELECTRICITY AND MAGNETISM FOR TEACHERS (3)
436. OPTICS FOR TEACHERS (3)
437. HEAT, WAVE MOTION, AND SOUND FOR TEACHERS (3)
439. ELEMENTARY SURVEY OF MODERN PHYSICS FOR TEACHERS (3)
441. DEMONSTRATION EXPERIMENTS FOR TEACHERS (3)
443. INTERMEDIATE ACOUSTICS (3)
444. MEASUREMENTS IN ACOUSTICS (2)
454. ATOMIC AND NUCLEAR PHYSICS (3)
456. ATOMIC AND MOLECULAR PHYSICS (3)
457. EXPERIMENTAL PHYSICS (1-2)
458. INTERMEDIATE OPTICS (4)
461. THEORETICAL MECHANICS (3)
467. INTERMEDIATE ELECTRICITY AND MAGNETISM (3)
470. SPECIAL TOPICS (1-9)
- 473-474. BIOPHYSICS (3 each)
477. X-RAY ANALYSIS OF SOLIDS AND LIQUIDS (3)
  
507. THERMODYNAMICS AND KINETIC THEORY (3) Classical and modern thermodynamics; introduction to statistical mechanics.
509. PHYSICS SEMINAR (1-3 per term) Topics from current research.
- 512-513. SOLID STATE PHYSICS (3 each) Analytical treatment of physical properties of solids: crystal structure, X-ray diffraction, lattice vibrations, paramagnetism, ferromagnetism, ferroelectricity; electron theory of metals, semiconductors. Prerequisite: Phys. 530.
517. STATISTICAL MECHANICS (3) Classical and quantum statistics, theory of ensembles, degenerate gases, applications to low temperature effects and cooperative phenomena. Prerequisites: Phys. 507, 561.
521. CRYSTAL STRUCTURE (3) Crystal symmetry, X-ray scattering, theory and techniques of crystal structure determination.
522. ADVANCED CRYSTAL ANALYSIS (3) Phase-determining methods in crystal analysis.
530. THEORETICAL MECHANICS (3) Newtonian mechanics; Lagrange's equations, Hamilton's principle; Hamilton's equations; coupled systems; waves in strings, central field problem; rigid bodies; elasticity; hydrodynamics.
532. ADVANCED THEORETICAL MECHANICS (3) Least action principle; canonical transformation; Lagrange and Poisson brackets; Hamilton-Jacobi equations; classical theory of fields. Prerequisite: Phys. 530.
533. THEORETICAL ACOUSTICS (3) Vibrating systems; transmission of disturbances through elastic and visco-elastic media. Prerequisite: Phys. 530.
- 553-554. NUCLEAR PHYSICS (3 each) Discussion and theoretical interpretation of basic experiments involving atomic nuclei and nuclear radiations. Prerequisite: Phys. 562.
557. ELECTRICITY AND MAGNETISM (3) Electro- and magnetostatics, Maxwell's equations, boundary value problems, electric and magnetic properties of material media.
558. ADVANCED ELECTRICITY AND MAGNETISM (3) Energy and momentum in the field, radiation theory, classical relativistic electron theory. Prerequisite: Phys. 557.

560. RESEARCH PROBLEMS (1-18) Introduction to research through individual assignments.
- 561-562. QUANTUM MECHANICS (3 each) The basic theory of wave and matrix mechanics, approximation methods, applications. Prerequisite: Phys. 530.
- 563-564. ADVANCED QUANTUM MECHANICS (3 each) Relativistic wave equations, quantum field theory, other advanced quantum theoretical topics. Prerequisite: Phys. 562.
571. ATOMIC PHYSICS (3) Experimental basis of modern physics; atomic spectra and structure, nuclear phenomena.
572. SELECTED TOPICS IN SPECTROSCOPY (3) Atomic and molecular spectra, experimental methods and theoretical analyses.
575. SPECIAL TOPICS (1-3 per term) Theoretical studies in any field of modern physics with or without associated experimental work. Prerequisite: Phys. 456.

## PLANT PATHOLOGY

ALVIN R. GROVE

*Acting Head of the Department of Botany and Plant Pathology*  
206 Buckhout Laboratory

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Fergus, Kneebone, Lewis, Mills, and Wernham; Associate Professors Bloom, Boyle, Couch, Graham, Schein, and Tammen; Assistant Professor Stambaugh.

A student may specialize in the study of plant diseases caused by fungi, bacteria, or viruses, and/or in their control, especially by plant breeding or by chemical means.

For admission a student must present at least 27 credits in botany, plant pathology, and biological science, of which not more than 6 may be in biological science. As many as 6 credits may be made up as undergraduate deficiencies after the candidate has been admitted to the Graduate School.

*See also "Botany" and "Genetics and Breeding."*

### PLANT PATHOLOGY (P PATH)

- |                                                                                                                                                                                                                                                                  |                                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| 404. DISEASES OF FIELD AND FORAGE CROPS (3)                                                                                                                                                                                                                      | <i>Mr. Couch</i>               |
| 408. PLANT PATHOLOGICAL TECHNIQUES (3)                                                                                                                                                                                                                           | <i>Mr. Bloom</i>               |
| 412. ADVANCED FOREST PATHOLOGY (3)                                                                                                                                                                                                                               | <i>Messrs. Fergus and Wood</i> |
| 419. (Bot. 419) MYCOLOGY (3)                                                                                                                                                                                                                                     | <i>Mr. Fergus</i>              |
| 425. DISEASES OF ORNAMENTAL AND FLORICULTURAL PLANTS (3)                                                                                                                                                                                                         | <i>Mr. Tammen</i>              |
| 428. DISEASES OF FRUIT AND VEGETABLE CROPS (3)                                                                                                                                                                                                                   | <i>Messrs. Bloom and Boyle</i> |
| 501. CLINICAL PLANT PATHOLOGY (3) Advanced course in diagnostic techniques to acquaint the students with specialized procedures for field and laboratory identification of plant diseases. Prerequisites: P.Path. 10, 408, P.Path. (Bot.) 419. Summer term only. |                                |
| <i>Mr. Couch</i>                                                                                                                                                                                                                                                 |                                |
| 509. PRINCIPLES OF PLANT INFECTION (3) Physiological processes of plant pathogenic bacteria and fungi occurring during incubation, ingress, and infection. Prerequisites: P.Path. 10 or 11, P.Path. (Bot.) 419. Winter term, odd years.                          |                                |
| <i>Mr. Schein</i>                                                                                                                                                                                                                                                |                                |



## PLANT PATHOLOGY

515. DISEASE RESISTANCE IN PLANTS (2-4) Stability of resistance, selection of resistant material, economics of control, special problems. Prerequisites: Bot. (Zool.) 22 or 33, P.Path. 10. Fall term, odd years. *Messrs. Wernham and Mills*
518. (Bot. 518) SPECIAL PROBLEMS (1-12) The prosecution of an assigned problem under the guidance of a staff member. Throughout the year as arranged. By appointment.
519. VIRUS DISEASES OF PLANTS (3) Nature, symptomatology, transmission, and control of virus diseases of plants. Fall term, even years. *Mr. Boyle*
520. PLANT PATHOGENIC BACTERIA (3) Bacteria causing plant diseases; methods of identification, inoculation, and control. Spring term, odd years. *Mr. Kneebone*
522. (Bot. 522) MYXOMYCETES, PHYCOMYCETES, AND ASCOMYCETES (4) Morphology, taxonomy, phylogeny, and life histories; identification and field work. Prerequisite: P.Path. (Bot.) 419. Winter term, even years. *Mr. Fergus*
523. (Bot. 523) BASIDIOMYCETES AND FUNGI IMPERFECTI (4) Morphology, taxonomy, phylogeny, and life histories. Prerequisite: P.Path. (Bot.) 419. Spring term, even years. *Mr. Fergus*
530. PLANT DISEASE CONTROL (3) Methods, and laboratory and field testing of materials used in plant disease control. Spring term, even years.
531. PLANT PATHOLOGY SEMINAR (1 per term) Selected topics of current research, history, and contemporary trends in plant pathology.

## POLITICAL SCIENCE

ELTON ATWATER, *Head of the Department*  
129 Sparks Building

*Degrees Conferred:* Ph.D., M.A., M.P.A.

*Graduate Faculty:* Professors Aspaturian, Atwater, Brewster, Ferguson, McGeary, Riemer, and Silva; Associate Professor Monat; Assistant Professor Albinski.

Students may specialize in American government, public administration, political theory, international relations, or comparative government.

Applicants for admission to the M.A. and Ph.D. programs will be expected to have at least 12 credits in political science or its equivalent. In exceptional cases students may be permitted to make up deficiencies after beginning their graduate programs.

Candidates for the M.P.A. must present for admission, or make up without graduate credit, at least 6 credits in political science and at least 3 credits in each of the following fields: economics, public finance, accounting or statistics, and psychology.

All candidates will take a core program and specialize in one of the following options: General Public Administration, Public Planning Administration, International Administration, or City Management.

### POLITICAL SCIENCE (PL SC)

401. POLITICAL BEHAVIOR (3)
411. AMERICAN POLITICAL THEORY (3) *Messrs. Hobbs and Riemer*
413. GOVERNMENT AND POLITICS OF THE SOVIET UNION (3) *Mr. Atwater*
414. FOREIGN POLICY OF THE SOVIET UNION (3) *Mr. Aspaturian*
415. INTERNATIONAL ORGANIZATION (3-6) *Messrs. Aspaturian and Atwater*
416. INTERNATIONAL LAW (3) *Mr. Aspaturian*

# POLITICAL SCIENCE

417. AMERICAN LOCAL GOVERNMENT AND ADMINISTRATION (3)
419. PUBLIC ADMINISTRATION (3) *Mr. McGeary*
421. MODERN POLITICAL THEORY (3) *Mr. Riemer*
426. POLITICAL PARTIES (3) *Miss Silva*
427. POLITICAL OPINION AND PROPAGANDA (3) *Miss Silva*
431. ANCIENT AND MEDIEVAL POLITICAL THEORIES (3) *Messrs. Hobbs and Riemer*
432. CURRENT POLITICAL TRENDS AND PROBLEMS IN THE UNITED STATES (3-9)
433. THE LAW OF LABOR-MANAGEMENT RELATIONS (3) *Mr. Brewster*
442. AMERICAN FOREIGN POLICY (3) *Mr. Atwater*
444. GOVERNMENT REGULATION (3) *Mr. Beasley*
445. ADMINISTRATIVE LAW (3) *Mr. Brewster*
446. JUDICIAL SYSTEMS (3)
447. CONSTITUTIONAL LAW: THE FEDERAL SYSTEM (3) *Miss Silva*
448. CONSTITUTIONAL LAW: GOVERNMENT AND THE INDIVIDUAL (3) *Mr. Brewster*
450. GOVERNMENTS AND FOREIGN POLICIES OF THE COMMONWEALTH OF NATIONS (3) *Mr. Albinski*
451. COMPARATIVE POLITICAL SYSTEMS (3) *Mr. Albinski*
456. GOVERNMENTS AND FOREIGN POLICIES OF LATIN AMERICA (3)
458. GOVERNMENTS AND FOREIGN POLICIES OF THE FAR EAST (3-6)
499. FOREIGN STUDY IN GOVERNMENT (2-6)
500. SEMINAR IN POLITICAL SCIENCE (3-12) Subject to be announced. *Mr. Brewster*
505. SEMINAR IN ADVANCED AMERICAN GOVERNMENT (3-12) *Mr. McGeary, Miss Silva*
509. RESEARCH TECHNIQUES IN POLITICAL SCIENCE (3) *Mr. Ferguson and Staff*
512. COMPARATIVE GOVERNMENT (3-12) *Mr. Albinski*
515. INTERNATIONAL RELATIONS (3-6) *Messrs. Aspaturian and Atwater*
517. INTERNATIONAL ORGANIZATION (3-6) *Messrs. Aspaturian and Atwater*
519. PUBLIC ADMINISTRATION (3-6) *Mr. McGeary*
521. POLITICAL THEORY (3-6) *Mr. Riemer*
535. GOVERNMENT REGULATION (3-6)
570. CURRENT TRENDS AND PROBLEMS IN ADMINISTRATION (3-6) *Mr. Ferguson*
571. THEORY OF PUBLIC MANAGEMENT (3-6) The role of the executive in modern government; the objectives of public administration; theories of administrative organization and practice. *Mr. Monat*
572. INTERNATIONAL ADMINISTRATION (3-6) The execution of foreign policies through national and international public and private organizations. *Mr. Thurber*
575. PUBLIC PERSONNEL ADMINISTRATION (3) Government personnel systems; current trends and problems; essentials of recruitment, classification and pay, ratings, supervision, training, and discipline. *Mr. Beasley*
576. PUBLIC FISCAL ADMINISTRATION (3) The role of the executive in fiscal planning; budget preparation; expenditure control; tax assessment and collection; investment of public funds. *Mr. Monat*
577. PUBLIC ORGANIZATION AND METHODS (3) Principles of government organization; management surveys; work measurement; methods of achieving efficiency and economy. *Mr. Ferguson*

## POLITICAL SCIENCE

578. PUBLIC PLANNING AND ZONING (3) Public planning agencies and their functions; essentials of effective planning and zoning; current trends and problems.
580. INTERNSHIP IN PUBLIC ADMINISTRATION (6)

## POULTRY SCIENCE

ARTHUR J. G. MAW, *Head of the Department*  
103 Weaver Building

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Professors Bressler, Hale, Margolf, Maw, and Murphy; Associate Professors Buss, Mueller, and Schein.

Students may specialize in poultry nutrition, poultry management, poultry products, poultry breeding, or animal behavior. In each area the program consists of a joint major between the Department of Poultry Science and one or more basic science departments. Admission requirements vary according to the area of specialization. Students with undergraduate majors in the basic sciences may qualify.

Excellent facilities are available for research in production, processing, and preservation of market eggs and dressed poultry, and in chick and poul nutrition. A specially designed and equipped Solar Laying House also provides facilities for investigation of production and behavioral problems encountered in large, concentrated populations of layers.

### POULTRY HUSBANDRY (P H)

401. (Psy. 401, Zool. 401) ANIMAL BEHAVIOR (3) *Mr. Hale*
402. SPECIAL TOPICS (3-12)
502. ADVANCED POULTRY NUTRITION (2-4) *Mr. Murphy*
503. ADVANCED POULTRY FARM MANAGEMENT (2-4) *Mr. Bressler*
504. ADVANCED MARKET POULTRY AND EGGS (2-4) Prerequisites: P.H. 1, 7; Ag.Ec. 33 or 2 additional credits in poultry husbandry. *Mr. Margolf*
505. RESEARCH IN POULTRY HUSBANDRY (1-10 per term) Prerequisite: 9 credits in poultry husbandry.
506. SEMINAR IN POULTRY HUSBANDRY (1-6)
582. (Psy. 582, Zool. 582) RESEARCH IN ANIMAL BEHAVIOR (2-6 per term) Research in special areas of animal behavior involving field or laboratory work. Prerequisite: P.H. (Psy., Zool.) 401; or Psy. 403. *Messrs. Hale and Schein*

## PSYCHOLOGY

DALE B. HARRIS, *Acting Head of the Department*  
101 Burrowes Building

*Degrees Conferred:* Ph.D., D.Ed., M.S.

*Graduate Faculty:* Professors Adams, Bernreuter, Carpenter, Hale, Guest, Guthrie, Hall, Harris, Lepley, Smith, and VanOrmer; Associate Professors Gorlow, Jackson, Piers, Schipper, Thevaos, Warren, and Whaley; Assistant Professors Hoffman, Prokasy, and Helen Snyder.



Graduate instruction and research opportunities are available in the following areas of psychology: general experimental, physiological and comparative, measurement and statistics, social and personality, developmental and educational, clinical, school, industrial and business, engineering and human factors.

Special research and training facilities include the Penn State Anechoic Chamber, the University Computer Center, the Laboratory for Physiological and Comparative Psychology, the Psychology Clinic, the Division of Counseling, and the Special Education unit.

Requirements for admission include a broad undergraduate preparation, a junior-senior scholastic average of B, a minimum of 12 credits in psychology, and a satisfactory graduate student rating on a scholastic aptitude examination. Applicants with a master's degree will have their admission evaluated with emphasis on the quality of their graduate program.

## PSYCHOLOGY (PSY)

400. HONORS COURSE IN PSYCHOLOGY (2-6)
401. (P.H. 401, Zool. 401) ANIMAL BEHAVIOR (3) *Mr. Hale*
403. INTRODUCTORY PHYSIOLOGICAL PSYCHOLOGY (3) *Mr. Warren*
411. PSYCHOLOGY OF THE PRESCHOOL CHILD (3)
412. ABNORMAL PSYCHOLOGY (3) *Mr. Guthrie*
414. INTERMEDIATE EDUCATIONAL PSYCHOLOGY (2-3) *Miss Snyder*
415. INTERMEDIATE STATISTICS IN PSYCHOLOGY AND EDUCATION (3) *Mr. Prokasy*
417. SOCIAL PSYCHOLOGY (2-3) *Mr. Singer*
418. MEASUREMENT OF PERSONALITY (3)
419. GUIDANCE AND EDUCATION IN SEXUAL AND MARITAL ADJUSTMENT (3) *Mr. Adams*
420. APPLIED SOCIAL PSYCHOLOGY (3)
422. PSYCHOLOGICAL METHODS OF MEASURING THE REACTIONS OF THE PUBLIC (3) *Mr. Guest*
423. TEST CONSTRUCTION AND STANDARDIZATION (2-3)
425. PSYCHOLOGY OF THE ELEMENTARY SCHOOL CHILD (2-3) *Mr. Whaley*
426. ADOLESCENCE (2-3) *Mr. Harris*
427. PSYCHOLOGICAL PRINCIPLES IN ADVERTISING (3) *Mr. Guest*
428. OPINION RESEARCH LABORATORY (3) *Mr. Guest*
429. PSYCHOLOGY OF COMMUNICATION (3)
431. INDUSTRIAL PSYCHOLOGY (3) *Mr. Smith*
432. INTRODUCTORY ENGINEERING PSYCHOLOGY (3) *Mr. Schipper*
433. PSYCHOLOGY OF OCCUPATIONAL BEHAVIOR (2)
436. MENTAL HYGIENE IN SCHOOLS (3)
437. PSYCHOLOGY OF ADJUSTMENT (3) *Mr. Gorlow*
438. THEORY OF PERSONALITY (3) *Mr. Jackson*
440. PSYCHOLOGY PROJECTS (1-6)
441. INDUSTRIAL MOTIVATION AND MORALE (3)
445. (C.D.F.R. 445) DEVELOPMENT THROUGHOUT ADULTHOOD (3)
450. MEASUREMENT OF ABILITIES (3)
474. PSYCHOLOGY OF EXCEPTIONAL CHILDREN (3) *Miss Piers*
482. INTRODUCTION TO CLINICAL PSYCHOLOGY (3)
500. SEMINAR: INTRODUCTION TO GRADUATE STUDY (0) For all new graduate students in psychology.
501. ADVANCED PSYCHOLOGY (3) Comprehensive study of general psychology. Prerequisite: 9 credits in psychology. *Mr. Lepley*
502. ADVANCED EDUCATIONAL PSYCHOLOGY (2-4) Psychological theories and principles underlying educational theories and practices. Prerequisites: Psy. 14 or 414; practice teaching or teaching experience.

## PSYCHOLOGY

503. **PHYSIOLOGICAL PSYCHOLOGY (2-6)** Correlations between structure and function of nervous system and human consciousness; laws and theories in fields of sensation, attention, association, affection, and thought. Prerequisite: 9 credits in psychology. *Mr. Warren*
504. **COMPARATIVE PSYCHOLOGY (2-4)** Behavior from standpoint of phylogenetic growth and development; biological implications; comparison of different types of animals, including man. Prerequisite: 9 credits in psychology. *Mr. Warren*
505. **RESEARCH PROBLEMS IN PSYCHOLOGY (1-15)** Prerequisite: 12 credits in psychology.
509. **ADVANCED THEORY OF LEARNING AND HABIT FORMATION (2-3)** Critical evaluation of major theories of learning: Hull, Guthrie, Tolman, Lewin; application of learning theory to major problems in psychology. Prerequisite: Psy. 4 or 414.
510. **HISTORY OF PSYCHOLOGY (3)** Theoretical systems, experiments, and personalities in development of modern psychology until about 1920. Prerequisite: 9 credits in psychology.
511. **CONTEMPORARY AMERICAN PSYCHOLOGY (2-3)** Current systems or schools of psychology with comparative study and critical analysis; points of view as presented by recognized leaders. Prerequisite: 9 credits in psychology. *Mr. Hall*
513. **EDUCATIONAL PSYCHOLOGY: DIFFERENTIAL (3)** Causes of differences in achievement and personality; psychological implications of methods used by schools in adjusting to individual differences. Prerequisites: Psy. 14 or 414; 6 credits at 400 level in psychology.
514. **EDUCATIONAL PSYCHOLOGY: LEARNING (2)** Experimentally determined facts about the learning process; synthesis of main theories of learning; application of principles related to: motivation, practice, retention, transfer, meaning, and problem solving. Prerequisites: Psy. 14 or 414; 6 credits at 400 level in psychology.
515. **ADVANCED STATISTICS IN PSYCHOLOGY AND EDUCATION (3)** Correlation theory and methods, discriminant function, and factor analysis; applications to mental test theory. Prerequisite: Psy. 415 or Ed.Ser. 590.
516. **THEORIES OF DECISION-MAKING (3)** Theoretical models and experimental evidence concerning choice behavior, strategies, and values, under riskless conditions and under uncertainty and risk.
517. **PSYCHOLOGY OF ATTITUDES AND OPINIONS (3)** Acquisition and control of attitudes and opinions, including beliefs, convictions, biases, prejudices, and ideologies as determinants of action. Prerequisite: 18 credits in psychology, including Psy. 417, 422, 437.
518. **PROJECTS IN EXPERIMENTAL PSYCHOLOGY (2-4)** Individual experimental projects; seminars on experimental design and instrumentation.
522. **SURVEY RESEARCH TECHNIQUES (3)** Sample and questionnaire designs for investigation of consumer reactions and social issues, and appropriate analytic procedures. Prerequisite: 3 credits in statistics. *Mr. Guest*
527. **STATISTICAL INFERENCE AND EXPERIMENTAL DESIGN (3)** Probability theory, sampling distributions, analysis of variance and covariance, analysis of trend, non-parametric statistics, experimental design. Prerequisite: Psy. 415 or Ed.Ser. 590.
528. **OPINION RESEARCH ADMINISTRATION (3-6)** Practicum in planning, development of techniques, and administration of the sample survey. Prerequisites: Psy. 15, 21, 422. *Mr. Guest*



529. (C.D.F.R. 529) SEMINAR IN CHILD DEVELOPMENT (1-6) Readings and reports on recent findings in child development. Prerequisite: 6 credits in child development or 6 in educational or child psychology, plus 3 in statistics.
534. ADVANCED ENGINEERING PSYCHOLOGY (3) Experimental studies of psychological factors affecting design and operation of machines. Prerequisites: Psy. 3 and 4, or Psy. 432 or 501.
535. HUMAN DEVELOPMENT (2-3) Psychological phases of human development throughout the life span; implications for school, community, and home. Prerequisite: 9 credits in psychology. *Mr. VanOrmer*
536. (C.D.F.R. 536) RESEARCH METHODS IN CHILD DEVELOPMENT (3) Prerequisites: 6 credits in child development and a course in statistics. *Mrs. Siegel*
537. SEMINAR IN INDUSTRIAL PSYCHOLOGY (3) Prerequisite: Psy. 431. *Mr. Smith*
538. PSYCHOLOGY OF PERSONNEL DEVELOPMENT (3) Industrial training in relation to psychological learning theory and experimental findings. Prerequisite: Psy. 431 or 414. *Mr. Smith*
539. MOTIVATION AND EMOTION (3) Systematic status of instinct, drive, motive, will, purpose; methodology and results of physiological, experimental, and clinical investigation of basic drives. Prerequisite: Psy. 503. *Mr. Hall*
540. SEMINAR IN CLINICAL PROBLEMS (1-6) Contemporary psychological theory, research, and methodology in relation to clinical psychology. Prerequisites: Psy. 542, 560.
541. PERSONALITY THEORY (3-4) Contemporary theories of personality and relevant research with emphasis upon normal processes. Prerequisite: Psy. 438.
542. PSYCHOPATHOLOGY (3-4) Theories of pathological behavior with reference to clinical and experimental data. Prerequisites: Psy. 412, 541.
543. SURVEY OF COUNSELING AND PSYCHOTHERAPY (3) Critical analysis of important systems of counseling and psychotherapy; history, rationale, and method. Prerequisite: Psy. 541.
549. (C.D.F.R. 549) THEORIES OF CHILD DEVELOPMENT (2-3) Historical background of the major theories concerning child development and behavior and their application. *Mr. Harris*
551. THEORY AND PRACTICUM IN CLINICAL APPRAISAL OF ABILITIES AND INTELLIGENCE I (3-4) Theories of intellectual behavior; introduction to clinical testing with emphasis on individual intelligence tests. Prerequisites: Psy. 450, 482; or 15 credits in psychology. *Miss Piers*
552. THEORY AND PRACTICUM IN CLINICAL APPRAISAL OF ABILITIES AND INTELLIGENCE II (3) Theory, development of tests, and research in intellectual assessment; practicum experience with institutionalized subjects. Prerequisite: Psy. 551. *Miss Piers*
553. ADVANCED THEORY OF CLINICAL ASSESSMENT (3) Problems in clinical assessment of cognitive functioning, such as assessment of brain injury, aphasic behaviors, etc. Prerequisites: Psy. 542, 552.
555. THEORY AND PRACTICUM IN CLINICAL ASSESSMENT OF PERSONALITY (3) Theoretical issues and research in clinical assessment with special reference to administration and interpretation of projective methods. Prerequisites: Psy. 542, 552. *Mr. Jackson*



## PSYCHOLOGY

556. THEORY AND PRACTICUM IN CLINICAL ASSESSMENT OF PATHOLOGICAL SYNDROMES (3) Current research and theoretical issues in the clinical assessment of pathological syndromes; includes practicum. Prerequisite: Psy. 555. *Mr. Guthrie*
557. ADVANCED PERSONALITY ASSESSMENT (3) Personality and measurement theories related to problems of prediction, diagnosis, and research. Prerequisite: Psy. 556.
560. PRACTICUM IN CLINICAL METHODS (3-6) Personality and vocational diagnostic evaluations and short-term counseling with adults and children. Prerequisites: Psy. 482, 541, 551.
561. CLINICAL PRACTICUM WITH CHILDREN (1-3) Diagnosis and counseling of child-parent problems of learning and adjustment; includes principles of school psychology. Prerequisite: Psy. 560. *Miss Piers*
564. THEORY AND PRACTICUM IN COUNSELING AND PSYCHOTHERAPY WITH ADULTS (3-6) Counseling with personal adjustment problems referred to the Psychology Clinic. Prerequisites: Psy. 543, 560. *Mr. Snyder*
567. THEORY AND PRACTICUM IN COUNSELING AND PSYCHOTHERAPY WITH CHILDREN (1-3) Practical experience in the Psychology Clinic in use of play therapy with young children; staff meetings; seminar on principles and techniques. Prerequisites: Psy. 543, 560, 564. *Miss Piers*
569. ADVANCED THEORY AND PRACTICUM IN COUNSELING AND PSYCHOTHERAPY (3-6) Practical experience in the Psychology Clinic in advanced nondirective therapy techniques; staff meetings; case conferences. Prerequisite: Psy. 564. *Mr. Snyder*
571. SOCIAL PSYCHOLOGY (3) Historical development of theory and methods; determinants and principles of complex social or interactional behavior; contemporary problems and research. Prerequisite: 3 credits in social psychology.
580. THEORY AND CONSTRUCTION OF ATTITUDE SCALES (3) Measurement of social, political, commercial, and industrial attitudes; questionnaire designs. Prerequisite: 3 credits in statistics.
582. (P.H. 582, Zool. 582) RESEARCH IN ANIMAL BEHAVIOR (2-6 per term) Research in special areas of animal behavior involving field or laboratory work. Prerequisite: Psy. (P.H., Zool.) 401; or Psy. 403. *Messrs. Hale, Schein, and Warren*
590. PROBLEMS IN CLINICAL RESEARCH (1-6) Prerequisite: Psy. 415.
591. SEMINAR ON TEACHING PSYCHOLOGY (1-3) Objectives and content of psychology; organization and presentation of material; teaching aids and techniques.

## RECREATION EDUCATION

FRED M. COOMBS, *in Charge of Recreation Education*  
244 Recreation Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

Students may prepare for park and recreation administrative positions in municipal, state, or federal agencies; semipublic or private agencies; hospitals or industries; or for leadership of special groups in a particular activity. The areas for specialization include: (1) history, philosophy, and principles; (2) administration and supervision; (3) planning park areas and facilities; (4) program content and application; (5) surveys and appraisals; (6) public administration; and (7) research.

## RECREATION EDUCATION

For admission an undergraduate major in recreation education is desirable; but a major in sociology, music, physical education, fine or industrial arts, theatre arts, or other related fields may be accepted.

Students who lack some of the prerequisite courses may be admitted but are required to make up the deficiency without degree credit.

### RECREATION EDUCATION (RC ED)

- 430. CAMPING AND OUTDOOR EDUCATION (3)
- 434. (L.Arch. 434) RECREATION AREAS AND FACILITIES (3)
- 456. SOCIAL RECREATION (3)
- 461. COMMUNITY RECREATION (3)
- 465. ADMINISTRATION OF RECREATION (3)
  
- 530. CAMP ADMINISTRATION (3) Camp site development; staff selection, training, and supervision; development of objectives and program planning; values inherent in outdoor and camping education. Prerequisite: Rc.Ed. 430.
- 533. RECREATION STUDIES, SURVEYS, AND APPRAISALS (3) Types, purposes, and methods of conducting recreation studies and surveys; procedures in appraisal of community recreation. Prerequisite: Ph.Ed. 530.
- 560. ADMINISTRATIVE PROBLEMS OF RECREATION (3) Administrative problems in park and recreation departments; departmental organization, finance, personnel, facilities, program, and public relations. Prerequisite: Rc.Ed. 465.

## ROMANCE LANGUAGES AND LITERATURES

FRANKLIN B. KRAUSS

*Head of the Department of Romance Languages*  
301 Sparks Building

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Professors Belasco, Chapman, Eyer, Hyslop, Krauss, and LeSage; Associate Professors Bleznick, Brentin, Moser, Sturcken, and Wadsworth; Assistant Professor Triolo.

The minimum requirement for admission to an advanced degree program will normally be 24 credits of post-intermediate work in language and literature. A student concentrating in either French or Spanish may, if he wishes, choose the second area as a minor.

### FRENCH (FR)

- 400. FRENCH LITERATURE OF THE RENAISSANCE (3)
- 405. FRENCH LITERATURE IN THE ROMANTIC PERIOD (3)
- 406. FRENCH LITERATURE IN THE REALISTIC PERIOD (3)
- 411. FRENCH PROSE OF THE 20TH CENTURY (3)
- 413. CONTEMPORARY FRENCH DRAMA (3)
- 416. FRENCH POETRY AND DRAMA OF THE 20TH CENTURY (3)
- 421. THE TEACHING OF ROMANCE LANGUAGES (3)
- 431. FRENCH LITERATURE OF THE CLASSICAL PERIOD (3)
- 433. THE AGE OF ENLIGHTENMENT (3)
- 471. PROBLEMS IN FRENCH LITERATURE (3-6)
- 490. ADVANCED COMPOSITION AND CONVERSATION (3)

## ROMANCE LANGUAGES AND LITERATURES

- \*1G. ELEMENTARY FRENCH FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.
501. FRENCH DRAMA OF THE CLASSICAL PERIOD (3) Origins and development of French classical comedy and tragedy, emphasizing the works of Corneille, Racine, and Molière.
549. SYMBOLISM (3) The anti-positivistic tradition in 19th century French literature dealing with the Symbolist School; its antecedents and its subsequent ramifications.
552. MEDIEVAL FRENCH LITERATURE (3) Familiarizes the student with Old and Middle French texts from the earliest monuments to Villon. Prerequisite: R.Ph. 551.
562. FRENCH THINKERS OF THE 18TH CENTURY (3)
570. VOLTAIRE AND ROUSSEAU (3)
571. SEMINAR IN FRENCH LITERATURE (3-12) Lectures on methods of research. Students will pursue common and individual investigations in fields selected after consultation with the instructor.
580. PROUST AND GIDE (3)

### ITALIAN (IT)

571. SEMINAR IN ITALIAN LITERATURE (3-6) Lectures on methods of research. Students will pursue common and individual investigations in fields selected after consultation with the instructor.

### PORTUGUESE (PORT)

571. SEMINAR IN PORTUGUESE LITERATURE (3-6)

### SPANISH (SPAN)

401. THE GOLDEN AGE (3)
402. DRAMA OF THE GOLDEN AGE (3)
403. DON QUIXOTE (3)
404. OLD SPANISH LANGUAGE AND LITERATURE (3)
405. SPANISH DRAMA OF THE 19TH CENTURY (3)
407. THE SPANISH NOVEL OF THE 19TH CENTURY (3)
408. THE CONTEMPORARY SPANISH NOVEL (3)
409. INTRODUCTION TO LATIN-AMERICAN LITERATURE (3)
410. INTRODUCTION TO LATIN-AMERICAN LITERATURE (3)
411. MEXICO: ITS LANGUAGE AND LITERATURE (3)
417. SPANISH LITERATURE IN THE ROMANTIC PERIOD (3)
421. THE TEACHING OF ROMANCE LANGUAGES (3)
471. PROBLEMS IN SPANISH LITERATURE (3-6)
490. ADVANCED COMPOSITION AND CONVERSATION (3)

- \*1G. ELEMENTARY SPANISH FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.

501. GOLDEN AGE LITERATURE (3) Nature and development of Spanish literature of the 16th and 17th centuries.

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\*No graduate credit is given for this course.



## ROMANCE LANGUAGES AND LITERATURES

538. THE GENERATION OF 1898 (3) Principal works and intellectual trends of the period with special emphasis on Unamuno.
549. MODERNISMO (3) The movement, its antecedents, and its followers, with special emphasis on Rubén Darío.
552. MEDIEVAL SPANISH LITERATURE (3) Familiarizes the student with Old Spanish texts.
565. LOPE DE VEGA (3)
567. CERVANTES AND HIS WORKS (3)
571. SEMINAR IN SPANISH LITERATURE (3-12) Lectures on methods of research. Students will pursue common and individual investigations in fields selected after consultation with the instructor.

### ROMANCE LITERATURE (R LIT)

544. NEOCLASSICISM IN THE ROMANCE LITERATURES (3) The neoclassical movement in the Romance literatures, with emphasis on French and Spanish.
545. ROMANTICISM IN THE ROMANCE LITERATURES (3) The Romantic movement in the Romance literatures, with emphasis on French and Spanish.
546. MEDIEVAL ROMANCE LITERATURES (3) Medieval writings in the Romance literatures, with emphasis on French and Spanish.
547. REALISM IN THE ROMANCE LITERATURES (3) The Realistic movement in the Romance literatures, with emphasis on French and Spanish.
554. THE RENAISSANCE IN THE ROMANCE LITERATURES (3) The effect of the Renaissance on the Romance literatures, with emphasis on French and Spanish.

### ROMANCE PHILOLOGY (R PH)

551. ROMANCE PHILOLOGY (3)
558. ADVANCED LINGUISTICS AND PHONETICS OF THE ROMANCE LANGUAGES (3)
573. THEORY AND TECHNIQUES OF TEACHING THE ROMANCE LANGUAGES (1-2)
574. METHODS AND BIBLIOGRAPHY IN ROMANCE LANGUAGES AND LITERATURES (1-2)

## RURAL SOCIOLOGY

MACKLIN E. JOHN

*Head of the Department of Agricultural Economics and Rural Sociology*  
1 Weaver Building

*Degrees Conferred:* Ph.D., M.S., M.Agr.

*Graduate Faculty:* Professors Bonser, Brown, and John; Associate Professors Bylund and Copp; Assistant Professors Fliegel and Freeman.

The entering student in the master's program should have as prerequisites 3 credits in rural sociology, 3 credits in sociology, and 3 additional credits in either field. If he does not have these prerequisites, he may take them at this University during the early part of his master's program.

## RURAL SOCIOLOGY

### RURAL SOCIOLOGY (R SOC)

402. CONSUMER BEHAVIOR AND THE AGRICULTURAL INDUSTRY (3) *Mr. Bylund*  
452. RURAL ORGANIZATION (3) *Mr. Copp*  
459. RURAL SOCIAL PSYCHOLOGY (3)
501. DEVELOPMENT OF RURAL SOCIOLOGY (2) Historical development with emphasis on American rural sociology.
502. ADVANCED RURAL SOCIOLOGY (3) Structure and functioning of rural society; evaluation of theoretical systems.
510. RURAL MIGRATION (2) Rural migration research and theory; application to governmental and community problems.
512. NATIONAL FARM ORGANIZATIONS (2) National farm organizations as social systems. Prerequisite: R.Soc. 452.
513. SOCIOLOGY OF CONSUMER BEHAVIOR (2) Sociological theory and research pertaining to consumer behavior. *Mr. Bylund*
514. VALUES IN RURAL SOCIETY (2) Values as dynamic forces in rural society.
515. EXTENSION ORGANIZATION AND METHODS (2) Agricultural and home economics extension as a social system with emphasis on techniques of organization and program development. *Mr. Brown*
516. CHANGE IN RURAL SOCIETY (2) Social change in rural society emphasizing prediction and control of the change process. *Mr. Fliegel*
551. RURAL SOCIOLOGY SEMINAR (1-6) Prerequisite: 6 credits in rural sociology, sociology, or psychology.

## SANITARY ENGINEERING

(See page 82, Civil Engineering.)

## SECONDARY EDUCATION

HERBERT A. SMITH, *Head of the Department*  
168 Chambers Building

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Professors House, McGarey, Patrick, Remaley, Smith, and Veon; Associate Professors Fagan, Fowler, and Kozak.

Graduate degree programs in the department are provided primarily for the advanced preparation of competent public school teachers.

In general, candidates for the M.Ed. in secondary education must have 18 approved undergraduate credits in education and psychology including practice teaching in an area appropriate to the major, and aptitude for and interest in advanced professional preparation. Applicants are encouraged to have had at least two years of successful teaching experience.

While candidates are required to specialize in secondary education, they are encouraged to acquire a general education in the social sciences, the behavioral sciences, and the humanistic foundations.

## SECONDARY EDUCATION

The M.Ed. degree may be earned, in general, in those fields outside of secondary education for which a master's degree has been approved, provided such a professional program is appropriate. Thus, for example, the M.Ed. degree may be earned with a major in English or chemistry. These programs require an approved minor in educational foundations.

### SECONDARY EDUCATION (SEC ED)

- 400. THE SCIENTIFIC DIRECTION OF LEARNING ACTIVITIES (2-4)
- 426. TEACHING MATHEMATICS IN THE SECONDARY SCHOOLS (4)
- 433. TEACHING SOCIAL STUDIES IN THE SECONDARY SCHOOLS (4)
- 436. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE SECONDARY SCHOOL (3)
- 437. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE SECONDARY SCHOOL (3)
- 438. TEACHING SCIENCE IN THE SECONDARY SCHOOLS (4)
- 443. READING PROBLEMS IN THE SECONDARY SCHOOL (2-3)
- 445. (El.Ed. 445) TECHNIQUES IN REMEDIAL READING (2-6)
- 451. SECONDARY EDUCATION IN AMERICA (3)
- 453. TEACHING ENGLISH IN THE SECONDARY SCHOOLS (4)
- 454. EXTRACURRICULAR ACTIVITIES IN THE JUNIOR AND SENIOR HIGH SCHOOL (2-3)
- 456. PRINCIPLES AND PROBLEMS IN BUSINESS EDUCATION (1-3)
- 459. IMPROVEMENT OF INSTRUCTION IN BUSINESS SKILL SUBJECTS (1-3)
- 460. CURRICULUMS IN BUSINESS EDUCATION (3)
- 461. IMPROVEMENT OF INSTRUCTION IN BASIC BUSINESS SUBJECTS (3)
- 462. TEACHING OF SHORTHAND AND TYPEWRITING (3)
- 463. TEACHING OF BOOKKEEPING (3)
- 466. TEACHING OF OFFICE PRACTICE (3)
- 468. TEACHING OF TYPEWRITING (2-3)
- 472. MEASUREMENT OF ACHIEVEMENT IN THE SECONDARY SCHOOL (2-3)
- 497. WORKSHOP IN SELECTED STUDIES IN SECONDARY EDUCATION (1-6)
  
- 510. INTERNSHIP IN SECONDARY SCHOOL TEACHING (3-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
- 511. INTERNSHIP IN BUSINESS EDUCATION SUPERVISION (3-6) Internship to take place in schools or educational situations where not regularly employed, under supervision of graduate faculty.
  
- 525. MODERN TENDENCIES IN EDUCATIONAL METHOD (2-3) Study of science supporting dynamic instruction; principles of teaching as guides; analysis of modern procedures; understanding of learning; substance versus plans. Prerequisite: 12 credits of undergraduate work in education.
  
- 532. SUPERVISION OF STUDENT TEACHERS (3) A course in supervision for master teachers, department heads, and college teachers with supervisory responsibilities in teacher education. Prerequisite: teaching experience and 18 credits in education, including at least 5 in methods.
  
- 537. (Bot. 537, Zool. 537) WORKSHOP IN THE BIOLOGICAL SCIENCES (3) Projects designed for teachers of biology in the secondary schools.
  
- 546. (El.Ed. 546) SEMINAR ON READING INSTRUCTION (3-6) Research procedures and materials in reading readiness, word perception, basic reading skills, vocabulary development, reading in content subjects. Prerequisite: Sec.Ed. 443 or El.Ed. 443.



## SECONDARY EDUCATION

550. PROBLEMS IN MODERN SECONDARY EDUCATION (1-4) Historical, psychological, social, and economic factors influencing secondary education; required as basic course of all graduate students in secondary education. Prerequisite: secondary school teaching.
551. SEMINAR IN CONTEMPORARY ISSUES IN THE SECONDARY SCHOOL CURRICULUM (2-3) Principles and philosophy of curriculum construction. Each student works out an individual problem in the secondary school curriculum. Prerequisites: 12 credits in education and psychology, and teaching experience.
552. SEMINAR IN CONTEMPORARY ISSUES IN LABORATORY STUDIES IN THE APPLICATION OF EDUCATIONAL METHOD (2-3) Analysis and application of outstanding studies in secondary education; integration of results of educational research with public school procedures. Prerequisites: 12 credits in education and psychology, and teaching experience.
553. ORGANIZATION AND ADMINISTRATION OF THE JUNIOR HIGH SCHOOL (2-3) Problems in reorganization of secondary education, with particular reference to philosophy, organization, and teaching problems of the junior high school. Prerequisites: 12 credits in education and psychology, and teaching experience.
556. (El.Ed. 556) READING CLINIC PRACTICE: ANALYSIS OF READING DISABILITIES (3-6) Analysis of extreme reading disabilities and recommended procedures; experience in preparation of case reports. Prerequisite: Sec.Ed. (El.Ed.) 445 or El.Ed. 444.
575. ADMINISTRATION AND SUPERVISION IN BUSINESS EDUCATION (3) Work of administrators, supervisors, and others responsible for improvement of instruction in business education; use of vocational testing; job analysis. Prerequisite: 6 credits in secondary education.
576. INTRODUCTION TO RESEARCH IN BUSINESS EDUCATION (3) Methods of research in business education; opportunity to compile annotated bibliographies on current problems; analysis and evaluation of significant research.
577. EVALUATION OF RESEARCH AND EMPIRICAL LITERATURE IN BUSINESS EDUCATION (3) Application of evaluation methods to current literature in business education; special attention to research studies. Prerequisite: Sec.Ed. 576.
578. SEMINAR IN BUSINESS EDUCATION (1-6) Intended for graduate students preparing theses or final documents, or for those working on special studies in business education. Prerequisite: Sec. Ed. 577.
585. CURRICULUM CONSTRUCTION (2-3) Functions of administrators, supervisors, teachers, pupils, and laymen in curriculum building to meet pupil and community needs.
594. SEMINAR IN SECONDARY EDUCATION (1-3) Conferences and discussions designed to meet the need for special study of particular fields in secondary education. Prerequisite: 12 credits of graduate work in education.
597. WORKSHOP IN CURRENT EDUCATIONAL PROBLEMS IN SECONDARY EDUCATION (1-6) For administrators, supervisors, experienced secondary teachers, guidance workers; administrative, supervisory, and instructional problems involved in an emerging educational program. Prerequisite: 12 credits of graduate work in education.
598. PROBLEMS, PROJECTS, AND AREA STUDIES IN SECONDARY EDUCATION (1-6) Independent work in the study of topics in secondary education or the development of new curriculums, materials, or procedures for teaching. Prerequisites: 12 credits of graduate work in education and approval of the department head.

## SOCIAL STUDIES

NEIL A. McNALL  
*Chairman of the Committee on Social Studies*  
 114 Sparks Building

*Degree Conferred: M.Ed.*

This program, designed to meet the needs of secondary school teachers, consists of at least 24 credits chosen from economics, history, human geography, political science, and sociology, and a minor of at least 6 credits in educational foundations. A candidate is expected to complete at least 3 credits in each of four fields and not more than 12 credits in one of them.

To undertake graduate work in this field, the student must have had solid preparation in the basic courses in history, political science, economics, and sociology; and he should have had some advanced undergraduate work in at least one of these fields. He should be certified for teaching social studies, and ideally he should have had teaching experience in this field as well.

## SOCIOLOGY

MACKLIN E. JOHN  
*Head of the Department of Sociology and Anthropology*  
 239 Sparks Building

*Degrees Conferred: Ph.D., M.A.*

*Graduate Faculty:* Professors Bernard, Clark, Foreman, Mather, F. R. Matson, and Mook; Associate Professors Baker, Dansereau, Dupree, M. B. Matson, and Theodorson.

Undergraduate preparation must include 12 credits in sociology and at least 7 in other social sciences, with a broad background in the arts and sciences preferred. Students of exceptional ability who are slightly deficient in undergraduate preparation may be accepted, on condition that they make up their deficiency in courses without degree credit.

### SOCIOLOGY (SOC)

- 400. SOCIOLOGICAL PRINCIPLES (3)
- 401. SOCIAL INSTITUTIONS (3)
- 403. ADVANCED SOCIAL PSYCHOLOGY (3)
- 405. SOCIAL ADJUSTMENT IN WORK LIFE (3)
- 408. SOCIAL ECOLOGY (3)
- 413. METHODS AND TECHNIQUES OF SOCIAL RESEARCH (1-6)
- 418. THE DEVELOPMENT OF SOCIAL THOUGHT (3)
- 423. POPULATION RESEARCH (3)
- 424. SOCIAL CHANGE (3)
- 426. INTRODUCTION TO PUBLIC WELFARE (3)
- 427. SOCIAL CASE WORK (3)
- 429. SOCIAL STRATIFICATION (3)
- 431. COMMUNICATION AND MASS SOCIETY (3)
- 450. COMMUNITY ORGANIZATION (3)
- 454. INDUSTRY AND THE COMMUNITY (3)

## SOCIOLOGY

455. OCCUPATIONS AND PROFESSIONS (3)  
470. USE OF STATISTICS IN SOCIOLOGY (3)  
499. FOREIGN STUDY IN SOCIOLOGY (2-6)
500. SEMINAR IN GROUP THEORY (1-3) The group as a unit of social structure and action.
501. ANALYTICAL SOCIAL THEORY (3) The nature, general types, and origins of sociological theory; problems in the logic of sociological inquiry.
502. CONTEMPORARY SOCIOLOGICAL THEORY (3) Survey of leading sociological works written during the last five decades.
503. RESEARCH SEMINAR IN SOCIAL PSYCHOLOGY (3-6) Design and conduct of research in areas of mutual interest in social psychology.
505. CURRENT SOCIAL THEORY (3) Current contributions to social theory; their relations to each other and to the larger theoretical structure.
506. SEMINAR IN SOCIOLOGICAL THEORY (3-6)
510. FIELD WORK IN SOCIOLOGY (1-6)
513. SEMINAR IN SOCIOLOGICAL RESEARCH PROBLEMS: A. RESEARCH TECHNIQUES; B. CURRENT RESEARCH (3-6) Prerequisite: 3 credits in statistics.
515. SEMINAR IN COMMUNITY STUDIES (3)
523. POPULATION PROBLEMS (1-6)
525. SEMINAR IN SOCIOLOGY (1-6) Research problems in theoretical and applied sociology.
530. RESEARCH ON MARRIAGE AND THE FAMILY (3) Training in methods and techniques of research in family relations. Experimental, statistical, and comparative studies are carried out, individually or cooperatively. Prerequisite: 3 credits of previous work in this field.
555. INDUSTRIAL SOCIOLOGY (3) Research methods and techniques in industrial sociology; current research, unexplored areas.
572. METHODS OF SAMPLING (3) Application of sampling techniques to sociological research.

## SOLID STATE TECHNOLOGY

RUSTUM ROY

*Chairman of the Committee on Solid State Technology*  
121 Mineral Sciences Building

*Degrees Conferred: Ph.D., M.S.*

The aim of this program is to provide an opportunity for the student interested in the structure, properties, and behavior of solid materials to obtain an integrated program of courses encompassing both the fundamentals of chemistry, physics, and mathematics and their technological and engineering applications.

The subject matter, taught by various departments, is grouped into four areas: (1) the structure of solids, (2) theory related to the solid state, (3) properties of solids, and (4) reactions of solids.



## SOLID STATE TECHNOLOGY

Course work should be so distributed that one area is encompassed in depth while a substantial number of credits is chosen from any combination of the other areas. Thesis research on various aspects of the solid state may be conducted in appropriate departments in the Colleges of Chemistry and Physics, Engineering, and Mineral Industries.

Entering students should hold a bachelor's degree in chemistry, physics, mathematics, geological science, engineering, ceramics, or metallurgy, or in a closely related field that will have included mathematics at least through integral calculus and a minimum of one year of physics and one year of chemistry. They should be specifically interested in an interdisciplinary program of study and research.

## SPEECH

ROBERT T. OLIVER, *Head of the Department*  
305 Sparks Building

*Degrees Conferred:* Ph.D., D.Ed., M.A., M.Ed.

*Graduate Faculty:* Professors McDonald, Oliver, Schug, Siegenthaler, and Zelko; Associate Professors Brubaker, Carter, Fife, Frick, Holtzman, Nelson, and White; Assistant Professor Dunham.

The student may specialize in speech arts (interpretation, drama, theatre); radio and television; rhetoric and public address (including discussion, communication, teaching of speech); speech science (voice, diction, phonetics, general semantics); or speech pathology and audiology.

The minimum undergraduate preparation required is 12 credits in speech, including a beginning public speaking course and speech science with group discussion and persuasion. Students who cannot meet this requirement in full may be admitted, but must make up their deficiencies without credit toward the graduate degree. Spch. 400 and Spch. 502 are required of all graduate students who do not have their equivalents.

### SPEECH (SPCH)

- |                                                                                                                                                                                                                    |              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| 400. TEACHING OF SPEECH (3)                                                                                                                                                                                        | Mr. Schug    |
| 402. GENERAL SEMANTICS (3)                                                                                                                                                                                         | Mr. Carter   |
| 410. ENGLISH PHONETICS AND PRONUNCIATION (3)                                                                                                                                                                       | Mr. Brubaker |
| 412. SPEECH COMPOSITION (3)                                                                                                                                                                                        |              |
| 415. EXPERIMENTAL AND APPLIED PHONETICS (3)                                                                                                                                                                        | Mr. Brubaker |
| 425. (Brct. 425) RADIO PROGRAMMING AND PERFORMANCE (3)                                                                                                                                                             | Mr. Nelson   |
| 431. ANATOMY AND PHYSIOLOGY OF THE EAR AND VOCAL MECHANISMS (3)                                                                                                                                                    | Mr. Brubaker |
| 435. (Brct. 435) RADIO AND TELEVISION PROGRAMMING (3)                                                                                                                                                              | Mr. Nelson   |
| 437. (Brct. 437) TELEVISION PROGRAMMING AND PERFORMANCE (3)                                                                                                                                                        | Mr. Nelson   |
| 445. CONTEMPORARY PUBLIC ADDRESS (3)                                                                                                                                                                               |              |
| 450. DISCUSSION: RESEARCH AND THEORY (3)                                                                                                                                                                           | Mr. Zelko    |
| 490. PSYCHOLOGY OF SPEAKING AND LISTENING (3)                                                                                                                                                                      | Mr. Holtzman |
| 500. SEMINAR IN AMERICAN ORATORY (2-4) History of American oratory, with application of critical standards to the work of specific orators. Prerequisite: 6 credits in speech, including Spch. 200.                |              |
| 502. RESEARCH METHODS IN SPEECH (3) Research design, thesis proposals, and background for research in graduate study. Prerequisite: 6 credits at the 400 or 500 level in speech, clinical speech, or theatre arts. |              |

## S P E E C H

505. HISTORICAL DEVELOPMENT OF SPEECH THEORY AND CRITICISM (2-4) Classical theories of speech-making from the earliest beginnings to the fall of the Roman Empire. *Mr. White*
506. HISTORICAL DEVELOPMENT OF SPEECH THEORY AND CRITICISM (2-4) Theories of speech-making from the Renaissance to the present. *Mr. White*
508. SEMINAR IN BRITISH ORATORY (2-4) History of British oratory; application of critical standards to the work of selected orators. *Miss Fife*
510. SEMINAR IN SPEECH PEDAGOGY (2-4) Advanced knowledge, theories, and principles, together with their philosophical, scientific, clinical, artistic, and educational implications for the teacher of speech. Prerequisite: Spch. 502 and 9 additional credits at the 400 or 500 level in speech, clinical speech, or theatre arts. *Mr. Carter*
520. SEMINAR IN SPEECH SCIENCE (2-4) Seminar in physical and physiological bases of speech and voice; introduction to laboratory techniques used in speech research. Prerequisite: 9 credits in speech, speech education, or psychology. *Mr. Brubaker*
540. SEMINAR IN PROBLEMS OF TELEVISION AND RADIO (2-4) Study and research in television and radio as they pertain to programming, production, relation to society, and speech. *Mr. Nelson*
550. SEMINAR IN ORAL PERSUASION (2-4) Theory and devices of persuasion; analysis of persuasive discourse. Prerequisite: 6 credits in speech including Spch. 200. *Mr. Holtzman*
552. ORAL COMMUNICATION IN INDUSTRY, BUSINESS, AND GOVERNMENT (2-4) Needs, practices, and methods in American industry, business, and government; methods of training adults in oral communication skills. *Mr. Zelko*
555. SPEECH COMMUNICATION: PROBLEMS AND PRINCIPLES (2-4) Prevalent theories of speech influence. *Mr. Oliver*
560. PUBLIC ADDRESS (2-4) Discussion and criticism of speech outline, manuscript, content, composition, and delivery. Prerequisite: 6 credits in speech including Spch. 200. *Mr. Schug*
575. RESEARCH PROBLEMS IN SPEECH (1-12) Advanced research on an individual basis in oratorical criticism, discussion techniques, persuasion, pedagogy, phonetics, speech science, and speech pathology. Prerequisite: 12 credits in speech or speech education.

## STATISTICS

JAMES B. BARTOO, *Chairman of the Committee on Statistics*  
231 McAllister Building

No advanced degree is offered in this field, but a candidate with a major in another field may choose a minor in statistics upon approval by his major department.

This minor is intended to facilitate development of a coherent program of study in this vital branch of the scientific method. The candidate will be expected to become conversant with the broad field of statistics and to become reasonably proficient in the statistical methods particularly useful in the subject-matter areas of his major field. The member of the candidate's committee representing the minor in statistics will have responsibility for determining course work acceptable in satisfying requirements for the minor.



The minimum requirements for a minor for a master's degree are 3 credits in mathematical statistics and 6 in applied statistics. For a doctor's degree a minimum of 15 credits in statistics is required for a minor, of which at least 6 must be mathematical statistics and at least 6 must be applied statistics.

Courses in mathematical statistics are: Math. 409, 410, 542, and 543.

Courses in applied statistics are: Ag. 400; A.B.Ch. 515; Ag.Ec. 505; Ag.Ed. 521v; Agro. 512, 545; B.S. 500, 501; Econ. 510; Ed.Ser. 490, 590; For. 450; I.E. 423; Meteo. 450; Min. 513, 514, 526; Psy. 415, 515, 527; and Soc. 470, 572.

## THEATRE ARTS

WALTER H. WALTERS, *Head of the Department*  
201 Schwab Auditorium

*Degree Conferred: M.A.*

*Graduate Faculty:* Professors Neusbaum, Smith, and Walters; Associate Professors Reifsneider and Yeaton.

Under certain circumstances the Ph.D. degree is offered by the Department of English with specialization in drama and minor work in theatre arts.

A course in basic acting, one in directing, and one in theatre crafts, or their equivalents, are required for admission. In addition, the student must have had 12 credits divided between speech and the arts (including music, sculpture, painting, architecture, and other courses in which art is practiced); or a minimum of 9 credits in one of these; or a minimum of 9 credits in English and literature, including at least 6 in dramatic literature, or 3 in dramatic literature and 3 in advanced creative writing.

### THEATRE ARTS (THEA)

- 404. STYLES OF ACTING (3-6)
- 412. ADVANCED SCENE DESIGN (3)
- 413. STAGE LIGHTING (3)
- 414. STAGE COSTUMING (3)
- 415. THEATRE ORGANIZATION AND MANAGEMENT (3)
- 421. ADVANCED PLAYWRITING (3)
- 431. HISTORY OF THE THEATRE (3)
- 433. DANCE FOR THE THEATRE (3)
- 442. CREATIVE DRAMATICS WITH CHILDREN (3)
- 443. MARIONETTES AND PUPPETRY (3)
- 451. DIRECTING (3)
- 452. CENTRAL STAGING (3)
- 470. THEATRE PRODUCTION (1-6)
- 481. (Brcst. 481) TELEVISION DRAMA (3)
  
- 501. PROBLEMS OF DIRECTING (3-6) Seminar in problems of production with particular stress on direction. Students will direct plays under staff supervision.
- 502. SEMINAR IN THE TECHNICAL PROBLEMS OF DRAMATIC PRODUCTION (3-6) Prerequisite: Thea. 11.
- 504. SEMINAR IN STYLES OF ACTING (3-6) Practical work required of each student.
- 506. EVALUATION AND APPRECIATION OF MODERN DRAMATIC ENTERTAINMENT (3) Prerequisites: Thea. 1, 61.



## THEATRE ARTS

507. SEMINAR IN FUNDAMENTAL THEORIES OF THEATRE AND DRAMA (3-6)

521. PLAYWRITING (3-6) Prerequisites: Thea. 21, 421.

## VOCATIONAL INDUSTRIAL EDUCATION

(See page 123, Industrial Arts Education and Vocational Industrial Education.)

## WILDLIFE MANAGEMENT

BERTIL G. ANDERSON

*Head of the Department of Zoology and Entomology*  
212 Frear Laboratory

OR

ROBERT E. McDERMOTT

*Head of the Department of Forest Management*  
109 Forestry Building

*Degree Conferred: M.S.*

Graduate programs in the field of wildlife management are offered by the Department of Zoology and Entomology for students primarily interested in the animal aspects, and by the Department of Forest Management for those primarily interested in the habitat aspects.

## ZOOLOGY

BERTIL G. ANDERSON

*Head of the Department of Zoology and Entomology*  
212 Frear Laboratory

*Degrees Conferred: Ph.D., M.S.*

*Graduate Faculty:* Professors Anderson, Anthony, Cooper, and Davis; Associate Professors Boyle and Wood; Assistant Professors Bellis and Smyth.

Students may specialize in animal behavior, bioacoustics, ecology, endocrinology, fishery biology, genetics, histology, ichthyology, invertebrate zoology, invertebrate physiology, or wildlife management.

In order to undertake graduate work in zoology, students are required to have had 24 credits in zoology and related biological sciences; and they should have had chemistry through organic chemistry. Courses in physics and mathematics are also advantageous. A limited deficiency can be made up without degree credit while pursuing graduate work.

### ZOOLOGY (ZOOL)

401. (P.H. 401, Psy. 401) ANIMAL BEHAVIOR (3)

403. (Ent. 403) SYSTEMATICS (3)

405. (Bot. 405) GENERAL CYTOLOGY (3)

*Mr. Hale*

*Mr. Boyle*

*Mr. Grun*

408. MAMMALOLOGY (4) *Mr. Davis*  
 410. GENERAL LIMNOLOGY (3) *Mr. Cooper*  
 415. THE LITERATURE OF ZOOLOGY (1) *Mr. Anderson*  
 416. THE METHODS OF RESEARCH IN ZOOLOGY (2) *Mr. Anderson*  
 417. INVERTEBRATE ZOOLOGY (3)  
 419. GENERAL ANIMAL ECOLOGY (3) *Mr. Bellis*  
 421. COMPARATIVE ANATOMY OF VERTEBRATES (4) *Miss Lehmann*  
 422. (Bot. 422) ADVANCED GENETICS (3) *Mr. Wright*  
 433. (Bot. 433) GENETICS, EUGENICS, AND EVOLUTION FOR TEACHERS (3) *Messrs. Wright and Grun*  
 437. HISTOLOGY (4) *Mr. Anthony*  
 440. EMBRYOLOGY (4) *Miss Lehmann*  
 441. ESSENTIALS OF HUMAN PHYSIOLOGY FOR TEACHERS (3)  
 444. ZOOLOGICAL PROBLEMS (1-6)  
 448. ORNITHOLOGY (3) *Mr. Wood*  
 450. ICHTHYOLOGY (3) *Mr. Cooper*  
 461. ANIMAL PARASITOLOGY (3)  
 471. VERTEBRATE PHYSIOLOGY (3)  
 505. (Bot. 505) CYTOLOGY AND CYTOGENETICS (3) Chromosome mechanism of heredity; relationship between plant and animal evolution and breeding and changes in chromosomes; cytological and cytochemical techniques. Prerequisite: Zool. (Bot.) 405 or 422. Spring term, odd years. *Mr. Grun*  
 508. ADVANCED PARASITOLOGY (3) Advanced work on the structure, life cycle, and control of parasites.  
 509. TECHNIQUES IN WILDLIFE MANAGEMENT (2) Evaluation of procedures designed to manage populations of game and fish; elements of statistics of birth and mortality rates; census methods. Fall term. *Mr. Davis*  
 512. SEMINAR (1) Review of current zoological literature. Required of graduate students majoring in zoology and entomology. Prerequisite: 12 credits in zoology or entomology.  
 520. SPECIAL TOPICS (1-6)  
 524. (Bot. 524) SEMINAR IN GENETICS (1 per term) *Mr. Wright*  
 525. HISTORY OF BIOLOGY (3) Historical development of biological knowledge and theories. Fall term.  
 528. (Bot. 528) POPULATION GENETICS (3) Factors affecting gene frequency, genotype frequency, genotype-environmental interaction, and genetic relationship in natural and artificial populations. Winter term, even years.  
 533. (Bot. 533) PROBLEMS IN GENETICS (2-6) Problems to suit needs of individual students; conferences and laboratory work. Prerequisite: Zool. (Bot.) 422. *Messrs. Wright and Grun*  
 537. (Bot. 537, Sec.Ed. 537) WORKSHOP IN THE BIOLOGICAL SCIENCES (3) Projects designed for teachers of biology in the secondary schools. Summer term.  
 541. COMPARATIVE PHYSIOLOGY (3) Dynamics of vital processes as shown in members of the animal kingdom. Prerequisites: Zool. 26; A.B.Ch. 1; A.B.Ch. 425 or Zool. 437. Winter term. *Mr. Smyth*  
 546. PRINCIPLES OF ANIMAL POPULATIONS (3) Ecological laws governing population growth and decline; reproductive and mortality rates; predation and composition as limiting factors. Fall term. *Mr. Davis*

## ZOOLOGY

551. FISHERIES MANAGEMENT (3) Basic principles underlying management of inland waters for fish production. Prerequisite: Zool. 450. Summer term, even years.  
*Mr. Cooper*
581. ADVANCED INVERTEBRATE ZOOLOGY (3) Morphology, physiology, taxonomy, and life histories of invertebrate animals.
582. (P.H. 582, Psy. 582) RESEARCH IN ANIMAL BEHAVIOR (2-6 per term) Research in special areas of animal behavior involving field or laboratory work. Prerequisite: Zool. (P.H., Psy.) 401; or Psy. 403.  
*Messrs. Hale, Schein, and Davis*
583. GENERAL ENDOCRINOLOGY (2) Anatomy and physiology of the organs of internal secretion; role of hormones in metabolism and development. Spring term, odd years.  
*Mr. Anthony*
587. BIOLOGY OF SEX (2) Hereditary and embryological aspects, problems in gonadal differentiation, cyclic reproductive phenomena, actions of the hormones. Spring term, even years.  
*Mr. Anthony*



# Other Elective Graduate Courses

The following courses are in fields in which neither major nor minor work is offered at this institution. The courses, however, carry graduate credit and, with the approval of the major department, may be applied toward the requirements for a degree either as elective courses or as a part of a general studies program. The usual restrictions upon the use of 400 series courses in degree programs apply to these courses.

## AGRICULTURE, GENERAL (AG)

400. INTRODUCTORY BIOMETRY (3)

*Mr. Bennett*

## ASTRONOMY (ASTRO)

430. GENERAL ASTRONOMY FOR TEACHERS (3)

470. SOLAR PHYSICS (3)

490-491. INTRODUCTION TO ASTROPHYSICS (3 each)

## BROADCASTING (BRCST)

425. (Spch. 425) RADIO PROGRAMMING AND PERFORMANCE (3)

*Mr. Nelson*

435. (Spch. 435) RADIO AND TELEVISION PROGRAMMING (3)

*Mr. Nelson*

437. (Spch. 437) TELEVISION PROGRAMMING AND PERFORMANCE (3)

*Mr. Nelson*

481. (Thea. 481) TELEVISION DRAMA (3)

482. CREATIVE BROADCASTING (3)

492. (Journ. 492) PUBLIC AFFAIRS BROADCASTING (3)

*Mr. Froke*

## ENGINEERING (ENGR)

422. ORDNANCE ENGINEERING: TORPEDO ENGINEERING (3)

431. DIGITAL COMPUTER PROGRAMMING (3)

450. PATENT FUNDAMENTALS (3)

500. SPECIAL TOPICS IN ENGINEERING (1-3)

531. ADVANCED DIGITAL COMPUTER PROGRAMMING (3) Nonnumerical applications; symbol manipulation, syntactical analysis, and translation of artificial languages; heuristic methods, learning mechanisms, artificial intelligence. Prerequisite: Engr. 431.

## GREEK (GREEK)

421. GREEK TRAGEDY (3)

422. GREEK COMEDY (3)

500. GREEK COMPOSITION (2) Translation of extended narrative passages into Attic Greek; thorough review of forms and syntax; attention to rhetorical elements of the language.

## HEALTH EDUCATION (HL ED)

406. RECENT DEVELOPMENTS IN SCHOOL HEALTH EDUCATION (3)

411. PRINCIPLES AND METHODS OF TEACHING SAFETY EDUCATION (3)

456. ADVANCED TECHNIQUES IN RURAL SCHOOL HEALTH (3)

## HEALTH EDUCATION

501. HEALTH IMPLICATIONS IN THE GROWTH AND DEVELOPMENT OF SCHOOL CHILDREN (3) Child growth and development emphasis for teachers; medical inspection and examination; preschool program; early habit formations; behavior problems; cooperation of parents, teachers, and children. Prerequisite: Hl.Ed. 215.
505. ADVANCED TECHNIQUES IN HEALTH EDUCATION (3) Prerequisites: Hl.Ed. 215, Psy. 437.
572. TESTS AND MEASUREMENTS IN HEALTH EDUCATION (3) Critical study, evaluation, and demonstration of tests and measures of health education; statistical computations of data. Prerequisites: Ph.Ed. 490, Hl.Ed. 215.

## INTERNATIONAL UNDERSTANDING (INT U)

400. WORLD AFFAIRS AND INTERNATIONAL UNDERSTANDING (3-6)

## LABOR-MANAGEMENT RELATIONS (L M R)

411. TRADE UNION ADMINISTRATION (3)
421. LABOR EDUCATION (3)

## LATIN (LATIN)

428. LUCRETIUS (3) *Mr. Krauss*
429. QUINTILIAN (3) *Mr. Krauss*
431. JUVENAL (3) *Mr. Krauss*
500. LATIN LITERATURE (3) Lectures and collateral readings on the major forms of Latin literature; readings in the original Latin to supplement the lectures. *Mr. Krauss*
501. ROMAN RELIGION AND PHILOSOPHY (3) Development of religious concepts at Rome from primitive Italic origins to the advanced forms that culminated in Roman Stoicism. *Mr. Krauss*
502. LATIN EPIGRAPHY (3) Lectures and readings on Roman inscriptions; illustrative exercises. *Mr. Krauss*
503. LATIN PALEOGRAPHY (3) The Latin alphabet, writing materials, Roman book and cursive hands; illustrative exercises. *Mr. Krauss*
504. ROMAN TOPOGRAPHY (3) Physical development of the city of Rome, its walls, aqueducts, bridges, streets, forums, public buildings, temples, etc.; building materials and methods of construction. *Mr. Krauss*
510. LATIN SEMINAR (3) *Mr. Krauss*
518. LATIN RESEARCH (1-3) Prosecution of an assigned problem under the guidance of a member of the department.

## LIBERAL ARTS (L A)

- 500-501. FUNDAMENTALS OF LINGUISTICS (3 each) Interrelated problems of language discussed from four points of view: modern structural linguistics, historical linguistics, social psychology, and philosophy.

## LIBRARY SCIENCE

### LIBRARY SCIENCE (L SC)

- 403. INTERMEDIATE DICTIONARY CATALOGING AND SUBJECT HEADINGS (3)
- 405. INTERMEDIATE REFERENCE WORK AND BIBLIOGRAPHY (3)
- 407. SPECIAL PROBLEMS IN SCHOOL LIBRARY SERVICE (6)

### MINERAL SCIENCES (MN SC)

- 411. INSTRUMENT TECHNIQUES APPLIED TO MINERAL SCIENCE PROBLEMS (1-3)
- 421. X-RAY DIFFRACTION (3)
- 510. X-RAY AND ELECTRON DIFFRACTION ANALYSIS AS APPLIED TO MINERALS AND METALS (2-4) Prerequisite: Mn.Sc. 421. Mr. Brindley
- 520. ELECTRON MICROSCOPY IN MINERAL SCIENCE RESEARCH (1-4) Prerequisite: Mn.Sc. 411, Unit B.
- 540. SOLID STATE STRUCTURES AND REACTIONS IN MINERAL SYSTEMS (2-4) Crystal chemical approach to solid state reactions, sintering, melting, hardness, thermal expansion, and behavior of matter under high pressure. Mr. Weyl

### NATURE EDUCATION (NA ED)

- 401. TRAINING IN NATURE FOR CAMP COUNSELORS (3)

### RELIGIOUS STUDIES (RL ST)

- \*400. RELIGIOUS IDEAS OF GREAT MEN (1)
- 401. RELIGIOUS PHILOSOPHY OF THE GREAT REFORMERS (3)
- 402. CONTEMPORARY RELIGIOUS THOUGHT (3)
- 410. BIBLICAL STUDIES: OLD TESTAMENT (3)
- 420. BIBLICAL STUDIES: NEW TESTAMENT (3)
- 430. RELIGION AND MORALITY (3)

### RUSSIAN (RUS)

- 426. DOSTOEVSKY (3)
- 427. TOLSTOY (3)
- 430. METHODS AND MATERIALS FOR TEACHING RUSSIAN (3)
- 450. HISTORY OF THE RUSSIAN LANGUAGE (3)
- 460. LINGUISTIC ANALYSIS OF CONTEMPORARY RUSSIAN (3)

†1G. TECHNICAL RUSSIAN FOR GRADUATE STUDENTS (3) Prepares student to translate technical and scientific texts. No previous knowledge of Russian is required.

- 501. READINGS IN RUSSIAN LITERATURE (3-6) Prerequisite: Rus. 4.
- 525. PUSHKIN (3) Pushkin's significance in Russian literature; his relation to other European literatures; *Eugene Onegin* and selected shorter works.
- 542. SEMINAR IN SOVIET LITERATURE (3-6) Works of representative Soviet writers; individual research in contemporary Soviet literature and literary criticism.

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\*May be repeated for a maximum of 3 credits.

†No graduate credit is given for this course.



## SLAVIC

### SLAVIC (SLAV)

550. OLD CHURCH SLAVIC (3) Reading and study of that corpus of religious and liturgical documents representing the first written records of a Slavic tongue.
560. THEORY AND TECHNIQUE IN SLAVIC LINGUISTICS (3-6) Analysis of the relationship of the Slavic languages; consideration of particular linguistic problems within one or more of the languages.

### VETERINARY SCIENCE (V SC)

400. VETERINARY ANATOMY AND PHYSIOLOGY (3)
401. INFECTIOUS DISEASES OF DOMESTIC ANIMALS (3)
515. (Bact. 515) VIROLOGY (2-4) Rickettsial and viral agents parasitizing man, animals, and microorganisms. Prerequisite: Bact. 410.

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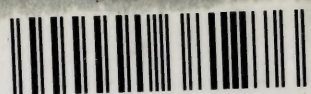


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